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Sophistication about Self-Control*

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Abstract

We propose a broadly applicable empirical approach to classify individuals as time-consistent versus naïve or sophisticated regarding their self-control limitations. Operationalizing our approach based on nationally representative data reveals that self-control problems are pervasive and that most people are at least partly aware of their limited self-control. Compared to naïfs, sophisticates have higher IQs, better educated parents, and are more likely to take up commitment devices. Accounting for both the level and awareness of self-control limitations has predictive power beyond one-dimensional notions of self-control that neglect awareness. Importantly, sophistication fully compensates for self-control problems when choices involve immediate costs and later benefits. Raising people's awareness of their own self-control limitations may thus assist them in overcoming any adverse consequences.

Keywords: self-control; sophistication; naïveté; commitment devices; present bias
JEL Classifications: *D91, D01*

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1 Introduction

People often find it difficult to exercise self-control when making inter-temporal choices. They struggle with temptation and may be unable to sufficiently delay pleasant activities, yet procrastinate when faced with unpleasant tasks. Behavioral economic theory predicts that people's self-control capacity—along with their sophistication about (awareness of) their own self-control problems—are both integral to the choices they make (e.g., Fudenberg and Levine, 2006; Laibson, 1997; O'Donoghue and Rabin, 1999, 2001; Phelps and Pollak, 1968; Strotz, 1956; Thaler and Shefrin, 1981). Naïve individuals, for example, may agree to suboptimal contracts (e.g., DellaVigna and Malmendier, 2004; Heidhues and Kőszegi, 2010), over-eat (O'Donoghue and Rabin, 2006; Ruhm, 2012), and under-invest in their own human capital (Steel, 2007), while sophisticated individuals may use commitment devices to help them achieve their long-term goals (e.g., Alan and Ertac, 2015; Ariely and Wertenbroch, 2002; Ashraf et al., 2006; Gineé et al., 2010; Kaur et al., 2015; Schilbach, 2019).

Operationalizing the notion of naïveté versus sophistication is, however, challenging. In their seminal paper, O'Donoghue and Rabin (1999) draw on the disparity between people's ideal, predicted, and actual choices to identify whether they lack self-control and, if so, whether they are aware of it. Specifically, there is a correspondence between time-consistent individuals' actual and ideal choices, which is lacking for those who are time-inconsistent. Sophisticates are aware of this discrepancy—and predict it—whereas naïfs expect to make the ideal choice, but then fail to do so. This theoretical framework has had considerable influence.[1] For example, "sin taxes" on unhealthy food or cigarettes have been proposed as a paternalistic policy to counteract over-consumption by consumers with self-control problems (e.g., Gruber and Kőszegi, 2001; O'Donoghue and Rabin, 2006). Numerous researchers have investigated the role of sophistication in contracting when agents are time-inconsistent (e.g., DellaVigna and Malmendier, 2004; Eliaz and Spiegler, 2006; Gottlieb, 2008; Heidhues and Kőszegi, 2010, 2015, 2017; Incekara-Hafalir, 2015; Kőszegi, 2010). Unfortunately, a corresponding empirical understanding of the role of sophistication in inter-temporal choice is lacking. While there is a vast empirical literature that infers or quantifies time-inconsistency,[2] only relatively few, recent studies address

[1] Google Scholar indicates O'Donoghue and Rabin (1999) has been cited 3,876 times as of June 10, 2021.

[2] See, for example, Andersen et al. (2008) and Andreoni and Sprenger (2012) for commonly used experimental approaches; Frakes and Wasserman (2020) and Martinez et al. (2017) for approaches that infer time-inconsistent

the distinction between naïveté and sophistication (beyond relying on the take-up of commitment devices to indirectly provide evidence for sophistication) or assess the determinants and implications of sophistication more broadly.

We address this issue by proposing and implementing a novel empirical strategy for measuring people's sophistication versus naïveté regarding their capacity for self-control, which is applicable not only to specific contexts or subgroups, but can be easily incorporated into large-scale, representative surveys. Specifically, we use information on people's ideal as well as their predicted and actual body weights to classify them as time-consistent, naïve, or sophisticated. Following a competitive tender process, we were offered the opportunity to integrate these weight-related items into the Innovation Sample of the German Socio-Economic Panel (SOEP-IS). For the first time, it is now possible to study both the incidence of self-control problems and the implications of naïveté and sophistication about self-control in nationally representative data. The richness of the SOEP-IS data allows us to test behavioral predictions across self-control types (see O'Donoghue and Rabin, 1999, 2001), distinguishing between choices that: (i) involve immediate costs with future benefits; (ii) involve immediate benefits with future costs; and (iii) potentially function as commitment devices. Doing so, we investigate and confirm the predictive power of our weight-based classification for choices across several different domains, ranging from health-related behaviors to financial decision-making and choices regarding education. More generally, we show that a two-dimensional characterization accounting for both the level and awareness of self-control capacity has predictive power beyond one-dimensional notions of self-control that neglect awareness.

Our work is most closely related to a handful of studies that—following O'Donoghue and Rabin (1999)—identify the naïveté and sophistication of time-inconsistent individuals through comparisons of their predicted and actual future behavior. Wong (2008) and Mandel et al. (2017) survey university students about their ideal and expected studying behavior for an exam. Later they are asked how much they actually studied.[3] This information is used to classify students as time-consistent, sophisticated, or naïve about their self-control limitations. Wong (2008) finds that both naïve and sophisticated students perform worse on exams than

preferences from task completion that is done at or close to a deadline and Heidhues and Strack (2021) for a criticism thereof; and Ameriks et al. (2007) and Incekara-Hafalir and Linardi (2017) for survey-based approaches.

[3]In one of their four studies, Mandel et al. (2017) collect data about people's ideal, predicted, and actual consumption of a fatty or sugary dessert.

time-consistent students, while Mandel et al. (2017) show that self-control strategies that work for naïfs do not necessarily work for sophisticates. Augenblick and Rabin (2019) propose the first experimental design that allows present bias and sophistication about present bias to be separately identified. Decisions about future versus immediate work identify people's capacity for self-control, while their degree of sophistication is separately identified by comparing their actual future work decisions with their prior predictions about their future behavior. They find that university students have self-control problems, but seem to be relatively naïve about them.[4]

We make several important contributions. First, our broadly applicable classification approach is theoretically grounded in the behavioral model of time-inconsistent decision-making proposed by O'Donoghue and Rabin (1999, 2001) and addresses several concerns with previous approaches. Much of the existing empirical evidence on dynamic inconsistency is generated from experimental choices over time-dated *monetary* payments. Augenblick et al. (2015, p. 1111) argue that the findings from these studies are subject to a number of confounders[5] and "may not be appropriate to reject a model defined over streams of *consumption*." We address these issues by studying the role of self-control in a number of consequential inter-temporal consumption decisions. This avoids the need to make inferences about self-control from monetary trade-offs. We also do not rely on the timing of task completion to infer time-inconsistency, an approach which has been criticized by Heidhues and Strack (2021). Importantly, we provide more direct evidence on sophistication than do studies on the take-up of commitment devices, and our observational study eliminates any threats to internal validity associated with possible experimenter demand effects in experimental studies of the take-up of commitment devices.

[4]Other approaches have also been used to identify people's sophistication about their self-control issues. Cerrone and Lades (2017), for example, rely on a lab-based incentivized monetary delay discounting task in conjunction with subjects' self-reported tendency to delay doing things in a timely manner. Using an app that provides free help in debt management, Kuchler and Pagel (2021) compare self-set debt repayment plans (interpreted as predicted repayments) to actual repayments. People's degree of sophistication is determined by the way additional financial resources affect the sensitivity of their consumption to paycheck receipts; those who are sophisticated are expected to act more patiently than those who are naïve when there are more resources available. Mahajan et al. (2020) classify people as time-consistent, sophisticated, or naïve using data from a randomized control trial of insecticide treated mosquito nets in India. Finally, field studies have also been used to estimate parameters characterizing discounting, present bias, and sophistication about own present bias, without classifying people's self-control type at the individual level. Fang and Wang (2015), for example, impose homogeneous parameters across individuals, Allcott et al. (2021) estimate average parameters, and Chan (2017) and Bai et al. (2021) estimate parameter distributions.

[5]Two examples are subjects' potential concerns about experimenter reliability in experimental designs with delayed monetary payments and hedging opportunities outside the experiment if subjects do not bracket narrowly.

Second, applying our approach to nationally representative data, we find that self-control problems are pervasive—only about one-third of the population behaves in a time-consistent manner. This finding emphasizes the potential for self-control problems to lead to serious welfare losses. Among those with self-control problems, the majority (57 percent) turn out to be at least partially aware of them. In line with the intuition that sophistication requires effective self-reflection, people with higher levels of intelligence and parental education are more likely to be sophisticated. Our results are thus helpful in shedding light on the hurdles that might prevent people from learning about their self-control problems (Ericson and Laibson, 2019).

Third, we address the lack of empirical evidence on whether and how sophistication about own self-control problems affects people's choices. Both the sign and size of the sophistication effect are theoretically ambiguous for repeated choices (O'Donoghue and Rabin, 1999) and O'Donoghue and Rabin (2001) predict that even small degrees of naïveté can potentially induce severe procrastination. We investigate the consequences of self-control problems and sophistication about them in a rich set of behaviors, and find that self-control problems are associated with procrastination. People with self-control problems are less likely to make choices that are initially costly but beneficial in the longer term, such as investing in education, saving, or exercising. Importantly, sophistication *fully* compensates for the penalties associated with having low self-control. This finding is notable as it suggests that there are two equally promising approaches to supporting people in overcoming the adverse consequences of self-control failures; decreasing their self-control problems or raising their awareness of their self-control issues.

The fact that sophisticated individuals generally have better outcomes than those who are naïve, can perhaps partly be attributed to their take up of commitment devices allowing them to manage their self-control problems more effectively. Examining individuals' commitment to retirement savings plans and gym memberships, we find evidence in support of this interpretation. Our results are in line with the theoretical prediction that sophisticated individuals are more likely to take up commitment devices than are those who are naïve (e.g., Fudenberg and Levine, 2006; Gul and Pesendorfer, 2001; Laibson, 1997; O'Donoghue and Rabin, 1999). An important distinction between our approach and that adopted in most previous studies is that we do not infer sophistication from take-up, but rather use an independent measure of

sophistication to test this key theoretical prediction of behavioral models of sophistication. Our empirical results regarding both self-control and sophistication are more ambiguous in the case of choices that involve immediate benefits with future costs, e.g., smoking, heavy drinking, or oversleeping.

Finally, it is vital that we develop a deeper understanding of not only the preferences that agents have, but also their awareness of those preferences and the choices they make in response. Developing the necessary evidence base requires that we have the ability to empirically distinguish between those who do and do not understand their own self-control limitations. Our proposed self-control classification approach based on self-reported weight predicts outcomes beyond the health domain, making it a viable strategy for empirically studying sophistication in many different contexts. This is a critical first step in opening up new channels for policy interventions that aim to raise awareness rather than cure time-inconsistency. Our classification also allows theoretical predictions about the relationship between sophistication and the use of commitment devices to be tested, enabling us to distinguish between alternative models of human behavior.

The remainder of the paper is structured as follows. Section 2 sets out the theoretical foundations of our approach, describes its empirical implementation, and derives behavioral predictions, while Section 3 introduces our data. Section 4 presents the empirical distribution of self-control types and characterizes time-consistent, naïve, and sophisticated individuals in terms of their socio-demographic characteristics, IQ, personality traits, and economic preferences. Section 5 tests behavioral predictions regarding the way that self-control problems and sophistication relate to choices involving immediate costs with later benefits versus immediate benefits with later costs, and on the take-up of commitment devices. We also provide evidence on partial sophistication and the relation between naïveté and overconfidence. Section 6 concludes.

2 Classification: Time-Consistent, Naïve, or Sophisticated

2.1 Theoretical Foundations

Classification of Self-Control Types. Like Phelps and Pollak (1968) and Laibson (1997), O'Donoghue and Rabin (1999) model self-control problems as a form of present-biased pref-

erences, using a two-parameter model that modifies exponential discounting (also called $\beta\delta$-preferences or quasi-hyperbolic discounting):

$$U^t(u_t, u_{t+1}, ..., u_T) = u_t + \beta \sum_{\tau=t+1}^{T} \delta^\tau u_\tau, \tag{1}$$

where $0 < \beta \leq 1$ and $0 < \delta \leq 1$. Total utility is given by U^t, u_t is flow utility in period t, and parameter δ represents long-run, time-consistent discounting. Further, β is a present-bias parameter that indicates whether and how much an individual favors the current period over later periods. If $\beta = 1$, $\beta\delta$-preferences coincide with time-consistent, exponential discounting. For an individual with time-consistent preferences, the relative preference for well-being at an earlier date over a later date is constant at any point in time. If $\beta < 1$, $\beta\delta$-preferences represent time-inconsistent, present-biased preferences; that is, individuals place more relative weight on the current period, in the current period, than in any previous period. In other words, $\beta < 1$ introduces additional discounting of any future period as opposed to the current period. The smaller is β, the stronger is the degree of present bias. Present-biased preferences are the most commonly used model of inter-temporal choice in behavioral economics (Ericson and Laibson, 2019) and they are frequently adopted to model self-control problems. In what follows, we will often refer to time-consistent individuals ($\beta = 1$) as individuals who do not have any self-control problems and time-inconsistent individuals ($\beta < 1$) as having self-control problems.[6]

In addition to the distinction between time-consistent agents and time-inconsistent agents, time-inconsistent agents can either be sophisticated (aware of their self-control problem) or naïve (not aware of their self-control problem).[7] O'Donoghue and Rabin (1999) assume that naïfs and sophisticates have identical preferences (i.e., identical β and identical δ) and differ only in their beliefs regarding their own future preferences. More precisely, a fully sophisticated person knows exactly what her future preferences will be and holds a correct belief $\hat{\beta}$ about β, i.e., $\hat{\beta} = \beta < 1$. Thus, a fully sophisticated person is able to correctly predict her future

[6]Like O'Donoghue and Rabin (1999), we focus only on time-inconsistency stemming from agents' present bias, ignoring the potential for agents to have a "future bias", i.e., $\beta > 1$. Future bias is rarely considered in the literature and our classification approach does not extend to this fourth type of agent.

[7]The distinction between naïfs and sophisticates goes back to Strotz (1956) and Phelps and Pollak (1968). However, O'Donoghue and Rabin (1999) are the first to systematically compare theoretical predictions regarding the inter-temporal choices of naïfs and sophisticates within the same model. Previous models either assumed naïve beliefs (Akerlof, 1991) or sophisticated beliefs (e.g., Laibson, 1997) for all agents. The planner-doer model of Thaler and Shefrin (1981) and the dual-self model of Fudenberg and Levine (2006) that do not rely on $\beta\delta$-preferences to model self-control problems also assume sophistication throughout.

behavior and is aware that it may deviate from the ideal behavior that a person without self-control problems will engage in. In contrast, a completely naïve person assumes himself to be time-consistent (i.e., $\hat{\beta} = 1$) even though $\beta < 1$. The result is that someone who is naïve expects to behave in an optimal manner in the future, but will not in reality manage to do so. Of course, complete naïveté and complete sophistication are two extremes. O'Donoghue and Rabin (2001) model intermediate cases by introducing the notion of partial naïveté; that is, people may be aware of their self-control problems, but underestimate their severity such that $\beta < \hat{\beta} < 1$. As a consequence, partially naïve individuals predict that their future choices will not coincide with the ideal choice, but still expect to make better choices than they actually do. Finally, time-consistent individuals are aware that they do not suffer from self-control problems ($\beta = \hat{\beta} = 1$) and as such, their ideal, predicted, and actual future choices coincide. Table 1 summarizes the characterization of people's self-control types, both in terms of the model parameters and their ideal, predicted, and actual choices.

Behavioral Predictions. O'Donoghue and Rabin (1999) distinguish between two kinds of choices for which self-control problems are key: (i) choices with immediate costs and delayed benefits (such as studying for an exam); and (ii) choices with immediate benefits but delayed costs (such as oversleeping or heavy drinking). They derive clear-cut predictions in the case of one-off decisions. Naïve individuals' choices depend on the extent of their present bias (i.e., the *present-bias effect*). If an action incurs an immediate cost, naïve individuals procrastinate (take an action later than is optimal); they preproperate (take an action earlier than is optimal) if an action involves an immediate benefit. In contrast, sophisticates are influenced by both their self-control limitations and their degree of sophistication, i.e., the *sophistication effect* on top of the present-bias effect. They correctly anticipate that they will not behave in an optimal way in the future, leading them to undertake activities sooner than otherwise similar naïfs would, regardless of whether the action involves immediate benefits or immediate costs. Thus, in the case of one-off choices, full sophistication mitigates procrastination if costs are immediate, but amplifies preproperation if benefits are immediate.

The present-bias effect is the same in more common and often more consequential scenarios involving repeated choices across multiple periods; present bias leads individuals to procrastinate when the choice is immediately costly and preproperate when the choice is immediately

beneficial (O'Donoghue and Rabin, 1999). The sophistication effect is fundamentally different, however, in the context of repeated rather than one-off choices. Sophisticates always preproperate when there is one action, yet they do not necessarily preproperate when undertaking repeated actions. As a result, there are no general theoretical predictions regarding the implications of full sophistication versus full naïveté for inter-temporal decisions involving repeated choices. Full sophistication can either intensify or mitigate self-control problems irrespective of the sequencing of costs and benefits (O'Donoghue and Rabin, 1999).[8] Overall, this implies that the distinction between the inter-temporal choices of sophisticates and naïfs is largely an empirical question. We must empirically evaluate whether—and in what circumstances—sophistication assists individuals in overcoming the challenges posed by their limited self-control. We undertake this analysis in Section 5.

2.2 Our Classification Approach

Our classification approach relies on information about people's ideal, predicted, and realized body weight. Specifically, we propose to elicit both self-control capacity and sophistication in large-scale surveys through respondents' reports of: (i) their current weight; (ii) the weight they would ideally have one year later; and (iii) the weight they expect to have one year later. One year later, they are asked to report (iv) their current weight again (see Table 2 for the wording of these questions). A time horizon of one year has the advantage of offering a realistic time frame for achieving desired weight changes, while making it unlikely that short-term shocks (such as special events, holidays, or seasonal effects) alter people's subjective ideal weight. Using this information, three types of people can be identified. Time-consistent individuals expect to reach their ideal weight and manage to do so. Naïfs believe that they will reach their ideal weight, but in the end do not. Sophisticates are those who do not expect to reach their ideal weight. The group of sophisticates thus includes all people who are aware that they do have self-control problems; some of them will be fully sophisticated, while others will be partially naïve.

[8] In a slightly different framework in which individuals can choose from multiple tasks instead of a single one, O'Donoghue and Rabin (2001) allow for varying degrees of sophistication and derive predictions for immediate cost activities only. They predict that fully sophisticated people do not procrastinate, while people who are completely naïve may procrastinate, and partially naïve people behave "in between" those who are completely naïve and those who are fully sophisticated (although the relation between the degree of sophistication and procrastination is not necessarily monotonic).

In our analysis, we empirically implement this classification approach—depicted in Figure 1—using detailed body weight information across 2017 and 2018.[9] Given our interest in self-control, we restrict our attention to the vast majority of people who desire to maintain or lose weight. The indeterminate sign of the sophistication effect implies that there is no clear-cut theoretical prediction regarding whether sophisticates' realized weight will exceed, equal, or, in fact, be smaller than ideal weight. This explains the single node in the classification tree for sophisticates. The inequalities in the nodes of the classification tree arise from two further methodological decisions. First, we retain in our analysis a small number of individuals who predict that they will have a lower weight next year than the weight they consider to be ideal. While this is an uncommon belief, we have no theoretical basis for excluding these individuals from the analysis. Second, all non-sophisticated individuals who realize a lower weight than they stated as ideal are classified as time-consistent. They make up approximately one-third of all time-consistent individuals.

Our focus on body weight is motivated by several factors. First, information about body weight is easy to elicit even in large-scale surveys. This allows us to empirically investigate the role of sophistication in inter-temporal decision-making using nationally representative data. Second, people's weight is the culmination of numerous choices about diet and exercise, each of which may require a degree of self-control. Not surprisingly, time-inconsistent preferences and self-control problems more broadly have been linked to poor eating behaviors and less exercising (e.g., Fan and Jin, 2013; Read and van Leeuwen, 1998; Scharff, 2009). Consequently, several studies document a clear association between self-control and BMI or obesity (e.g., Cobb-Clark et al., 2019; Fan and Jin, 2013; Stutzer and Meier, 2016). Finally, people's weight is driven by choices such as having a healthy diet and exercising that are salient—and consequential—for nearly everyone. People often care a great deal about their weight; many would prefer ex-ante and ex-post to eat and weigh less than they actually do (Ruhm, 2012).[10]

[9]Details of these measures are provided in Section 3. Responses to all weight-related questions are recorded in full kilograms (kg). To account for rounding error and the uncertainty associated with predicting weight, we allow for a margin or error of 2 percent when calculating whether the respective inequalities hold. That is, if predicted or actual weight is within the range of $\pm$ 2 percent of ideal weight, we consider them to be equal. In most cases, this allows for a maximum deviation of 1kg (for people whose ideal weight is between 50kg and 99kg) or 2kg (for people whose ideal weight is between 100kg and 150kg). We also show in Section 5.5 that the margin of error we choose (within a reasonable range) is of little consequence to our empirical results.

[10]Using nationally representative samples for each European Union member state, Kafatos et al. (1999) document that people perceive food, fat, sugar, genetics, and physical activities to be the most important factors influencing personal weight gains. In a representative sample of the U.S. population over 2013-2016, 49

An important feature of our approach is that we rely on a self-reported, subjective measure of own ideal weight instead of one informed by medical standards only. In our view, subjective ideal weight is a good benchmark for people's utility-maximizing weight if they were to have time-consistent preferences since the elicitation of subjective ideal weight allows individuals to consider the costs and benefits of weight loss given their personal circumstances. Of course, we cannot rule out the possibility that people do not fully consider all of the costs and benefits of losing (or gaining) weight when they report their ideal weight. However, several features of our data emphasize that people's subjective ideal weight provides a reasonable benchmark for our classification approach. First, respondents do not seem to perceive the ideal weight question as "make a wish for your weight". In fact, 49 percent of individuals report an ideal weight above the weight range that is classified as "normal" by World Health Organization (medically ideal BMI ranges between 18.5 and 24.9).[11] This indicates that individuals do consider costs of losing weight when stating their ideal weight, even more so given that the common beauty ideal is slimness. Moreover, the difference between subjective ideal weight and the medically ideal BMI is increasing in own initial weight (see Appendix Figure A2)—suggesting that people take their current weight into account when stating their ideal weight aims, making them realistic.[12]

3 Data

Our empirical analysis relies on novel data from the German Socio-Economic Panel's (SOEP) Innovation Sample (SOEP-IS; Goebel et al., 2019). The SOEP-IS comprises more than 5,500 people living in over 3,500 separate households and has been constructed to support the development and testing of novel survey instruments (see Richter and Schupp, 2015). Like the core SOEP, the SOEP-IS is a nationally representative annual household panel study.

Following a competitive tender process, we were given the opportunity to integrate two new questions about people's ideal and predicted future body weight into the survey administered to a subset of SOEP-IS respondents. These two questions, in combination with existing questions

percent of adults (67 percent of obese adults) reported trying to lose weight in the previous 12 months (Martin et al., 2018).

[11] https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi. Appendix Figure A1 illustrates the distribution of subjective ideal weight in our sample compared to the medically ideal weight range.

[12] We also considered the possibility that the weight gap (between the 2017 and the ideal weight) varies by gender. However, a Kolmogorov–Smirnow test rejects this hypothesis, indicating that the weight gap distributions for men and women do not differ significantly.

about actual body weight over two consecutive years, form the basis of our self-control classification described in Section 2. Specifically, in 2017 we asked respondents to report their current as well as their ideal and predicted future weight one year later (in this order); in 2018 we then asked people to report their current weight again (see Table 2). As interviews were conducted face-to-face, the scope for understating one's current weight is limited.[13] The average reported current weight in 2017 in our sample results in an average BMI of 27.2 (26.0) for men (women), which is very close the average BMI of men (women) of 26.7 (25.1) in 2017 as stated in official German statistics.[14]

Overall, our weight-related questions were administered to 1,780 respondents in 2017 and 2018. Non-response rates for each of the body weight questions are very low (1.8 to 3.0 percent), leading us to drop only 88 individuals (4.9 percent) with incomplete information on any of these four questions (see panel A in Appendix Table B2). The distribution of responses to each of the body weight questions among the 1,692 respondents with complete weight information is presented in Appendix Figure A3. Patterns of non-response across observable characteristics do not indicate that non-response bias is a serious concern.[15] This, along with the representativeness of the SOEP-IS sample more generally, allows us to draw conclusions about sophistication and naïveté regarding own self-control problems that are much more representative than previous studies.[16]

As noted above, we focus our attention on the vast majority of people wishing to either maintain their current weight or to lose weight. This leads us to drop 133 individuals whose ideal weight is higher than their actual 2017 weight (i.e., those wishing to gain weight) from the estimation sample. We also exclude 45 respondents whose weight changes by more than 10kg between 2017 and 2018, suspecting that these individuals may have experienced pregnancies or serious health conditions. Importantly, in Section 5.5 we demonstrate that relaxing these sample restrictions does not alter our findings. Our final estimation sample consists of 1,514

[13] We find no differences in the distribution of the actual weight and the predicted weight loss by the interviewer's gender. Neither women nor men seem to report a lower weight or have more optimistic weight loss goals when being interviewed by someone of the opposite sex.

[14] See https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Gesundheitszustand-Relevantes-Verhalten/Tabellen/koerpermasse-maenner.html or -frauen.html, respectively.

[15] Specifically, predicted weight has the highest non-response rate. There is no difference, however, in the actual 2017 weight of those who do and do not report their predicted weight. There are no significant differences in socio-demographic variables, measures of cognitive skills, and trait self-control among those who do and do not answer the four weight questions. The only exception is that women and older respondents are more likely not to respond to one or more of the weight questions. See panels B and C in Appendix Table B2.

[16] Appendix B compares our SOEP-IS extract to the core survey of the SOEP to ensure representativeness.

individuals. Their weight gap distributions are compared to those for the sample of 1,692 respondents with non-missing weight information in Appendix Figure A4.

Overall, respondents of SOEP-IS answer several hundred survey items. The data also contain detailed measures of people's socio-demographic characteristics (e.g., gender, age, and family background) as well as their economic preferences (e.g., time and risk preferences), personality traits (Big Five), and cognitive ability (measures of fluid and crystallized intelligence)—allowing us to study how these factors vary with the individual level of self-control and the degree of sophistication. Moreover, the SOEP-IS data contain rich information on people's decisions regarding both behavioral choices with immediate benefits and later costs (such as alcohol consumption, smoking, and oversleeping) and behavioral choices with immediate costs and later benefits (obtaining higher levels of education, exercising for health reasons, and savings), as well as on the take-up of commitment devices. We can thus empirically study how self-control problems and sophistication about them affect these choices.

We provide more details about our various outcome and control measures as we introduce our empirical analysis in Sections 4 and 5. Definitions for all measures can be found in Appendix Table A1.

4 Results: Classification and Characterization of Self-Control Types

4.1 Classification of Self-Control

We begin by using our information about people's body weight to identify: (i) whether they expect to achieve their ideal body weight next year; and, if so, (ii) whether they actually do. This classification approach, depicted in Figure 1, allows us to capture both the prevalence and awareness of self-control limitations in the population by comparing people's predicted and actual future weight to their ideal weight.[17] The resulting distribution of self-control types is shown in Figure 3. Approximately one-third (34 percent) of individuals are time-consistent (i.e., have no self-control problem), while 29 percent are naïve about their self-control problems and 37 percent are classified as partially or fully sophisticated. There are two main insights. First, more people appear to have self-control problems than do not. Second, people with self-control

[17]The distributions of these two key disparities (in percent) are displayed in plots (a) and (b) of Figure 2 respectively. People's predicted future weight exceeds their ideal future weight by as much as 15 percent or more. Actual future weight exceeds their ideal weight by as much as 25 percent or more, though some people weigh less than they previously thought was optimal.

problems are more likely to be at least partially sophisticated regarding their limited capacity for self-control than not. It is interesting to compare our results to those obtained in the few previous studies with more limited samples that are summarized in Table 3. While estimates of the share of self-control types vary, our two main insights based on a large and representative population are generally consistent with these previous studies.[18] Moreover, our data indicate that slightly more than 80 percent of individuals who are classified as time-consistent in 2018 had already achieved their ideal weight in 2017. This provides some evidence for the stability of our type classification over time.

Sensitivity Analyses and Validation. We also test the sensitivity of the distribution of types to our sample restrictions and to the margin of error we allow. Relaxing one or both of our sample restrictions leaves the share of self-control types largely unaltered. Depending on sample specifications, between 33 and 34 percent of people are time-consistent, 37 to 38 percent are sophisticated, and the share of naïfs remains at about 29 percent (see Appendix Table A2). In addition, our preferred classification allows for a margin of error of two percent in people's ideal weight.[19] If we do not allow for any margin of error and strictly enforce weight loss goals (see Appendix Figure A6), the share of individuals classified as time-consistent is smaller and the share of sophisticated individuals is larger. Allowing for a margin of error greater than two and up to five percent, increases the share of people who are time-consistent and lowers the share who are sophisticated, while leaving the share of naïfs remarkably constant. Importantly, our two key insights remain stable across all robustness checks; more people have self-control problems than do not and most people with self-control problems are sophisticated rather than naïve about them.

As a validation exercise regarding our type classification, we compare the mean levels of self-control as assessed using the Brief Self-Control Scale (BSCS; Tangney et al., 2004) across all three self-control types. The BSCS does not address sophistication, but measures the level of trait self-control using self-reported responses on 5-point scales to 13 items which were administered to the SOEP-IS respondents in 2017. The 13 items are provided in Appendix Table

[18] Augenblick and Rabin (2019) find lower levels of sophistication. However, the authors note that, in their study, "conclusions about sophistication are complicated by participants' unexpectedly strong preference to behave consistently with their earlier predictions" (p. 942) and that the low degree of sophistication could also be due to subjects not being familiar with the experimental task. In contrast, individuals are likely to be knowledgeable about their weight in our context.

[19] For 97 percent of our sample, this margin corresponds to an effective deviation of one kilogram above or below ideal weight. Appendix Figure A5 illustrates the kilogram range associated with other margins of error.

A3 (for more details, see Cobb-Clark et al., 2019). No item of the BSCS refers to weight, eating behaviors, or exercising. Higher values indicate greater levels of self-control. Average BSCS scores across types indicate a clear ranking, with time-consistent individuals scoring the highest, followed by naïfs, then sophisticates (see bottom row in Table 4). This ranking is confirmed when we investigate the distribution of BSCS scores by type, where equality in distributions can be rejected between sophisticates and both naïfs and time-consistents, but not between naïfs and time-consistents (see Figure 4). We regard this as evidence that our classification is valid; the ranking of (self-reported) trait self-control is logically consistent with our classification of people as time-consistent (i.e., without any self-control problems), naïve, and sophisticated. In particular, since sophisticates are aware of their self-control problems it is plausible that they score themselves lower on the self-assessed BSCS than naïfs who underestimate their degree of self-control problems.

A potential concern regarding our classification strategy could be that stating an ideal weight that is lower than the current weight may serve as a "psychological commitment device" to lose weight. If such a psychological commitment device was effective, we might overstate the share of time-consistent individuals. However, as illustrated in Appendix Figure A7, this is not the case as weight changes over a year do not differ between: (i) our respondents in the year just after they were asked the ideal weight question (2017–2018; red bars); (ii) the same sample one year later (2018–2019, when the ideal weight question was not asked again in the baseline year 2018; orange bars); and (iii) other SOEP-IS respondents who never answered the ideal weight question since they were not selected to participate in the self-control innovation module (2018–2019; purple bars). Pairwise Kolmogorov–Smirnov tests of equality of distributions fail to reject that distributions differ; $p = 0.99$ for red versus orange, $p = 0.88$ for red versus purple, and $p = 0.62$ for orange versus purple observations.

Finally, if naïfs and sophisticates report systematically lower ideal weights than time-consistents, it could be the case that they are classified as time-inconsistent due to an unrealistically low ideal weight. However, this is not the case, with naïfs' and sophisticates' ideal BMI higher than that of time-consistent individuals (see Table 5).

4.2 How Do Characteristics Vary with Self-Control Type?

There is hardly any previous evidence characterizing how naïve and sophisticated individuals differ from each other and from time-consistents. Our data allow for a comprehensive investigation of how people's characteristics vary with their self-control type. This is helpful in highlighting not only who is more vulnerable to self-control problems, but also who might be less aware of them. Policies offering commitment devices and other interventions aimed at supporting individuals with low self-control capacity could thus be more targeted.

Individuals' average demographic characteristics across self-control type are reported in the upper panel of Table 4 (columns 1 to 3), along with pairwise tests for their equality (columns 4 to 6). Appendix Table A1 provides the exact definitions of the variables we use in this section. Average age is highest for those individuals who are time-consistent. The finding that older people appear to have fewer self-control problems is in line with Cobb-Clark et al. (2019) who study trait self-control only, without distinguishing between naïfs and sophisticates. The gender disparity in our sample is neither large nor statistically significant. Sophisticates have better educated parents and time-consistents are slightly more likely to be Protestant, but we do not observe significant differences in other dimensions of family background across self-control types. East Germans are significantly less likely to be naïve. They are less likely to have self-control problems—re-affirming the findings in Cobb-Clark et al. (2019)—and, if they do, are more likely to be aware of them. It is intuitive that exposure to the suppressive regime of the former German Democratic Republic (GDR) may result in higher levels of self-control and greater awareness of self-control problems. This is consistent with the need for GDR residents to be cautious in what they said and did, so as not to jeopardize their educational and career opportunities, preserve their individual freedom (Fulbrook, 2008), and protect their families and friends (Jahn, 2014).

People's initial body weight in 2017 is closely linked to their self-control type, see Tables 4 and 5. As expected, those without any self-control problems (time-consistents) have the lowest weight (73kg) on average. Interestingly, there is also a significant gap in the average body weight of naïve and sophisticated individuals; sophisticates are more than 4kg heavier than naïfs, despite being of equal average height. Sophisticates therefore have an average BMI in 2017 that is approximately 1.4 points higher than that for naïfs, irrespective of gender (see

also Figure 5 for the full distribution of self-control types along BMI). These differences in weight and BMI between sophisticates and naïfs raise the possibility that people find it easier to recognize (i.e., become sophisticated about) their self-control problems the larger those problems become. Sophisticates may thus suffer from larger self-control problems than naïfs.[20] This would be in stark contrast to the standard assumption made in the theoretical literature that naïfs and sophisticates differ only in their awareness—but not in their level—of their self-control limitations. However, an alternative interpretation of the differences in weight and BMI across sophisticates and naïfs that we cannot rule out is that sophisticates may be heavier due to the sophistication effect.[21]

Our data also contain measures of cognitive skills that rely on test scores (see Appendix Table A1 for the measures and how they are elicited, and the lower panel of Table 4 for their relationship with self-control types). Since sophistication may require higher levels of self-reflection, one could expect that sophisticates have higher cognitive skills. Indeed, sophisticates score higher on both crystallized IQ that results from mental training as well as largely inherited fluid intelligence than naïfs do.

We also consider whether people's economic preferences and personality traits vary by type. All of these measures are standardized and rely on self-reported responses. In general, sophisticates differ significantly in most respects from time-consistent and naïve individuals, with slightly smaller differences between sophisticates and naïfs. They are less conscientious, emotionally stable, open, agreeable, and patient than naïfs and time-consistents. According to their self-reports, naïfs are statistically similar to those who are time-consistent. The fact that naïfs are—or report to be—similar to time-consistent individuals may reflect overconfidence in their self-perception that may not only be limited to the extent of their self-control. We will further inquire into the link between naïveté and overconfidence in Section 5.7.

[20]Similarly, Mahajan et al. (2020) and Cerrone and Lades (2017) find evidence for stronger present bias of sophisticated than naïve individuals. Based on a planner-doer framework, Ali (2011) derives theoretical predictions on the extent to which people become sophisticated by learning from their own past self-control failures.

[21]Eating behavior—an immediate benefit with later cost activity—is a major determinant of weight. The sign of the sophistication effect for repeated, immediate benefit activities such as eating is indeterminate in O'Donoghue and Rabin (1999).

5 Results: Self-Control, Sophistication, and Economic Choices

5.1 Estimation Strategy

Although behavioral economic theory predicts that the choices of sophisticates and naïfs will be substantially different, there is a notable lack of empirical evidence either confirming or refuting this.[22] To fill this gap, we turn to studying the implications of people's self-control type for the choices they make. As theoretical predictions depend on the nature of the decision being made, we distinguish between: (i) choices that involve immediate costs and future benefits (obtaining education, exercising for health reasons, and saving); (ii) choices that involve immediate benefits but come at future costs (alcohol consumption, smoking, and oversleeping); and (iii) choices that may function as commitment devices (committed saving plans and exercising at the gym).[23] Table 6 presents summary statistics for these outcomes by self-control type.

We use the following empirical model to assess the relationship between the outcomes we consider and people's self-control type:

$$Y_i = \alpha_0 + \alpha_1 SCP_i + \alpha_2 AW_i + \boldsymbol{X}_i'\boldsymbol{\gamma} + \varepsilon_i, \tag{2}$$

where Y_i is the outcome for individual i; SCP_i is an indicator for having a self-control problem that takes the value 1 if the individual is naïve or sophisticated, and 0 if the individual is time-consistent; AW_i is an indicator of awareness (sophistication) about one's self-control limitations that takes the value 1 if the individual is (partially or fully) sophisticated, and 0 if one is naïve or time-consistent; and ε_i denotes the error term. The vector $\boldsymbol{X}_i'$ includes the following set of control variables: basic demographic characteristics (gender, immigration background, and sibship size), body height, 2017 body weight, and time preferences (patience) as well as fixed effects for age, federal state of residence, and interview month. As robustness checks, we present results from other models that also account for additional factors such as marital status, family structure, religion, education, labor market outcomes, and parental education—depending on

[22] Wong (2008) shows that naïve and sophisticated students perform worse on exams than their time-consistent classmates, while Mandel et al. (2017) show that people's self-control type predicts a one-time decision regarding how much of an unhealthy snack to eat.

[23] We categorize choices into (i) vs. (ii) on the basis of the active decision to do something rather than the more passive failure to do something. For this reason, smoking, for example, is considered a choice involving immediate benefits and future costs, even though the avoidance of smoking may also have future health benefits, but immediate costs in terms of reduced utility.

the context. We do not claim that conditioning on the factors included in $\boldsymbol{X}_i'$ is sufficient to give equation (2) a causal interpretation. We regard ours as a descriptive analysis. However, since empirical estimates are generally unavailable for both sign and explanatory power of the sophistication effect, we feel confident that our results provide novel and valuable insights—especially as they are based on nationally representative data.[24]

OLS estimation of the model specified in equation (2) allows us to gauge the implications of people's self-control problems and their awareness of their limitations for the choices they make. Specifically, α_1 captures the effect of having a self-control problem, the "present-bias effect". The coefficient α_2 captures the additional effect of being aware of one's self-control problem, which O'Donoghue and Rabin (1999) refer to as the "sophistication effect".[25] We can make comparisons between the choices of different self-control types by using estimates of these two coefficients to calculate marginal effects. The differential effect of being naïve rather than time-consistent (the omitted reference category) is estimated by $\hat{\alpha}_1$, while the differential effect of being sophisticated rather than naïve is estimated by $\hat{\alpha}_2$. The sum $\hat{\alpha}_1 + \hat{\alpha}_2$ provides an estimate of the differential effect of being sophisticated rather than time-consistent. In presenting our results, we thus report both coefficient estimates (along with their significance levels) as well as an additional test for whether they offset each other such that their sum equals zero (i.e., $\hat{\alpha}_1 = -\hat{\alpha}_2$).

5.2 Choices Involving Immediate Costs and Later Benefits

Theory predicts that self-control problems lead people to be less likely to make choices that impose immediate costs but pay off in the longer run. Thus, we expect $\hat{\alpha}_1 < 0$ and $E[Y_i]$ to be lower for those who are naïve than for those who are time-consistent. There is no clear-cut prediction, however, regarding the sign of the sophistication effect (i.e., $\hat{\alpha}_2$) in repeated

[24] Although we cannot rule them out, the usual threats to causality are not as obvious in our setting because we have very little theoretical basis for speculating on the unobserved factors that might drive people's traits (self-control) and realized outcomes. This ambiguity regarding the actual threats to causal identification—and especially their sign and size—makes approaches to bound coefficients (as suggested by Altonji et al., 2005; Ichino et al., 2008; Oster, 2019) not ideal in our setting. These approaches require the strong assumption that we can learn about selection on unobserved characteristics using information about selection on observed characteristics.

[25] If we follow O'Donoghue and Rabin (1999) and assume that naïfs and sophisticates have the same degree of self-control problems, α_2 captures the sophistication effect only. If the extent of self-control problems differs across self-control types, α_2 reflects the difference in the extent of naïfs' and sophisticates' self-control problems on top of the sophistication effect. Given the estimates of α_1 and α_2 for outcomes with immediate costs (see Table 7), this results in a conservative estimate of the sophistication effect as, if anything, sophisticates have larger self-control problems than naïfs.

choice contexts such as ours. It is an open, empirical question whether sophistication mitigates or reinforces the adverse effects of present bias in those choices that involve immediate costs and future benefits. We address this question by estimating equation (2) for four separate outcomes: (i) total years of education; as well as binary indicators of (ii) graduation from an academic-track secondary school (required for college entrance); (iii) regular exercise; and (iv) any monthly savings.

Table 6 displays average values of the four outcome variables by self-control type. Table 7 presents our estimation results which include estimated coefficients (both in absolute and relative terms) in columns 1 to 4, as well as a test for whether the effect of being sophisticated offsets the effect of having a self-control problem (column 5). The adjusted R^2 for each model is reported in column 6. Both tables convey the same three key results. First, having a self-control problem is negatively associated with choices that involve immediate costs and future benefits. Second, being sophisticated about one's self-control problem has a positive effect. With the exception of savings, both effects are generally statistically significant. Finally, we cannot reject the hypothesis that these two effects completely offset each other leaving the choices of sophisticated individuals statistically equivalent to those of people who do not have self-control issues. Importantly, this implies that sophistication seems to fully compensate for the penalty associated with limited self-control.

Education. Our years of education measure captures all the degrees that people obtain. It is constructed by summing the years typically required to obtain each degree rather than the years people actually spend in education. This implies that higher values unambiguously reflect higher levels of education rather than, for example, grade repetition. Completing a degree requires effort which people typically find costly. Education also involves opportunity costs in the form of foregone earnings. For both reasons, education constitutes an excellent example of an outcome that results from repeated choices imposing immediate costs, but having later benefits.

Our results indicate that people with self-control problems have, on average, almost half a year (3.3 percent) less education than those who are time-consistent (see Table 7). This equates to 11.2 percent of their post-compulsory years of education. They are also 5.9 percentage points (pp.) less likely to have a degree that qualifies them for college entrance. The sophistication ef-

fect is even larger, but in the opposite direction, implying that the education penalty associated with a lack of self-control is fully compensated by the effect of being sophisticated.

We next consider whether there is evidence of reverse causality; i.e., the possibility that education affects people's capacity for self-control or their awareness of their self-control limitations. Specifically, we use a series of compulsory schooling reforms that took place in German states in the 1950/60s (see Pischke and von Wachter, 2008) as a natural experiment to estimate the causal effect of schooling on: (i) the likelihood of having a self-control problem; and (ii) conditional on having a self-control problem, the chances of being sophisticated. Appendix C provides background information regarding the reform, while Appendix Table C1 highlights the variation in the timing of the reform we exploit. Two-stage-least-squares (2SLS) estimates are presented in Appendix Table C2 along with the results from a number of specification checks. Although the first-stage results indicate that our reform instrument has sufficient power in the majority of cases, none of our second-stage estimates are statistically significant. Effects are imprecisely estimated and not always economically small, however, their direction is opposite to our expectations. Additional schooling tends to increase self-control problems and to decrease people's sophistication. Thus, this supplementary instrumental variable analysis gives us no reason to believe that our main findings are driven by reverse causality. If anything, reverse causality bias would attenuate our results. As an alternative test, we also include measures of crystallized intelligence and parental education in our main specification to account for people's acquired skills when investigating their educational choices. We find that sophistication has a significant positive association with years of education in this expanded specification (see Appendix Table A4).

Exercise. Our measure captures whether people exercise at least once a week.[26] Exercise is often an investment activity that involves immediate psychic, time, and financial costs in the expectation of future health benefits (e.g., DellaVigna and Malmendier, 2004, 2006). For those people who really enjoy the physical sensation of exercising however, exercise may be better characterized as a consumption good involving the opposite self-regulation problem (Ericson and Laibson, 2019). Fortunately, our data allow us to disentangle alternative motives for

[26]Exercise is measured in 2019 (if available) after people's body weight data is collected in 2017 and 2018. This minimizes the potential for reverse causality, i.e., the possibility that the choice to exercise influences weight in 2017 or 2018 and hence people's self-control type.

exercising. We begin by focusing only on exercise that is done predominantly for health reasons which we regard as an investment choice (see Appendix Table A1).

Our estimates indicate that people with self-control problems are 5.5 pp. (24.5 percent) less likely than are time-consistent individuals to exercise weekly to improve their health (see Table 7). Sophistication works to reduce this self-control penalty; sophisticates are 4.5 pp. (20.0 percent) more likely to exercise weekly than are naïfs. The present-bias effect is significant at the 10 percent level (p-value 0.06), while the sophistication effect just fails to achieve statistical significance (p-value 0.101).

The picture is consistent when we ignore people's stated reasons for exercising and instead restrict our sample to those: (i) with below median physical health; (ii) who struggle to climb stairs; and (iii) over the age of 50 (see Appendix Table A5). For these people, exercising is likely to require substantial physical effort. Smaller sample sizes result in reduced estimation precision. Nonetheless, there is evidence that present bias reduces investments in exercise for those people likely to be in bad health, while sophistication increases them. In contrast, we find little relationship between self-control and exercise for those who report exercising for fun rather than for their health, or in models that do not condition on the motivation for exercise.

Savings. Saving also imposes an immediate cost—a reduction in current consumption—in return for a later benefit. One of the strengths of our data is that we have information on people's motive for, and method of, saving. As our interest is in the role of self-control for people's active savings choices, we focus on an indicator of savings that takes the value 1 if households usually save each month for precautionary reasons, but are not using a regulated savings plan to build their assets; and 0 otherwise. We consider regulated savings plans for asset formation as a commitment device in Section 5.4. As savings information is provided at the household level, we assign a combined self-control type to partners living in couples.[27]

As is the case for education and exercising, self-control problems appear to reduce the chances that people usually have precautionary savings, though our estimates are not significant at conventional levels (see Table 7). This suggestive evidence is consistent with Strömbäck et al. (2017) who also find that people with good self-control are more likely to save. Sophistication has a significant role in offsetting limited self-control. At the same time, there may be

[27]We assign households a self-control problem indicator of 1 only if both spouses have a self-control problem (and 0 otherwise), and, conditional on having a self-control problem, we assign a sophistication indicator of 1 if at least one partner is sophisticated about it.

substantial heterogeneity in the savings choices of those with and without home mortgages. In particular, home owners may be less able to save if they are currently paying off their mortgage. When we focus on a sample of households without mortgages, we find that having a self-control problem significantly reduces the likelihood of any monthly savings by 8.3 pp. (14.5 percent), while sophistication increases it by 12.0 pp. (20.9 percent). These conclusions are robust to adding controls for family income and focusing on individual-level information about self-control issues and sophistication (see Appendix Table A6).

Overview. People with self-control problems make fewer investment choices that impose immediate costs but are eventually beneficial, than do those who are time-consistent. In this regard, our proposed classification of self-control types provides empirical evidence that confirms the theoretical predictions from various models of self-control failure (e.g., Fudenberg and Levine, 2006; Laibson, 1997; O'Donoghue and Rabin, 1999, 2001; Thaler and Shefrin, 1981) and is consistent with previous empirical studies of trait self-control (e.g., Cobb-Clark et al., 2019; de Ridder et al., 2012; Moffitt et al., 2011). At the same time, our results regarding the importance of sophistication are novel. They provide the first empirical assessment of the sign and magnitude of the theoretically ambiguous sophistication effect. We show that, conditional on having a self-control problem, sophisticated individuals are more likely to make investment choices that impose immediate costs than those who are naïve. Importantly, sophistication fully compensates for the lack of self-control across all of the choices we study (see column 5 of Table 7).

5.3 Choices Involving Immediate Benefits and Later Costs

We now consider choices that yield immediate benefits but have later costs. Specifically, we investigate binary indicators for alcohol consumption (both frequency and intensity), current smoking behavior, and the tendency to oversleep (see Appendix Table A1). All three can reasonably be regarded as pleasurable activities that raise current utility. They may also, however, compromise future outcomes, for example, through adverse effects on health and well-being or reduced productivity.

O'Donoghue and Rabin (1999) predict that people are more likely to choose options that involve immediate benefits and future costs if they have a self-control problem, i.e., we expect that $\hat{\alpha}_1 > 0$. The sophistication effect (estimated by α_2) in repeated choices is theoretically

ambiguous however, making the link between awareness of one's self-control limitations and outcomes an empirical question. We investigate both issues.

Descriptive statistics for our four outcome variables by self-control type are presented in Table 6, while the results of estimating equation (2) are given in Table 8. Consistent with theoretical predictions, people with self-control problems are more likely to smoke and oversleep on average than are those who are time-consistent (see Table 6). Interestingly, the sophistication effect is weakly positive; that is, sophisticated individuals are somewhat more likely to smoke, oversleep, and drink a large amount of alcohol than are naïve individuals. Our results are less consistent and not statistically significant, however, once we condition on individuals' characteristics (see Table 8). Moreover, the relative effect sizes are considerably smaller than those we find for choices involving immediate costs. These conclusions are unaltered when we account for a richer set of individual characteristics including marital status, the presence of children, religion, educational attainment, current and past employment status, as well as labor market and household income (see Appendix Table A7).

Taken together, our results suggest that self-control may play less of a role in resisting immediately pleasurable activities with long-term costs, than it does in promoting investment choices involving immediate costs with long-term gains. We can only speculate about why this is the case. One possibility is that resisting the temptation to engage in a pleasurable activity may rely more heavily on people's affective reaction to visceral urges and the ability to suppress one's immediate impulses, rather than having time-consistent preferences per se. If anything, sophistication tends to aggravate self-control problems in pleasurable activities with long-term costs—similar to the sophistication effect O'Donoghue and Rabin (1999) hypothesize for one-off activities.

5.4 Take-up of Commitment Devices

Models of sophisticated agents with self-control problems predict that there will be a demand for commitment (e.g., Fudenberg and Levine, 2006; Gul and Pesendorfer, 2001; Laibson, 1997; O'Donoghue and Rabin, 1999). That is, sophisticated individuals strictly prefer to restrict their own future choice set rather than retaining the full choice set. A growing empirical literature investigates the take-up of commitment devices as a means of indirectly demonstrating the existence of sophistication. Schilbach (2019) offers an encompassing overview of the evidence

on the demand for commitment regarding health-related behaviors, savings, work-related or real-effort tasks, among others (e.g., Alan and Ertac, 2015; Ariely and Wertenbroch, 2002; Ashraf et al., 2006; Gineé et al., 2010; Kaur et al., 2015). While there is some evidence that people do take up commitment devices, they are typically not willing to pay for commitment. However, the lack of a desire to commit does not necessarily imply naïveté, as people might value flexibility in the future (Augenblick and Rabin, 2019; Laibson, 2015). Moreover, nearly all of these studies cannot rule out the possibility that the observed demand for commitment is driven by social desirability bias or a taste for commitment that is independent of sophistication. There is a need for more direct measures of sophistication such as the one we introduce in this paper.

Our conceptual approach and data allow us to investigate whether people's sophistication about their self-control problems is indeed associated with a higher take-up of commitment devices. This contrasts with previous studies that use the take-up of commitment devices as an indication of sophistication. We consider two potential commitment devices: (i) an indicator for having a savings plan requiring regular, automated contributions; and (ii) exercising for health reasons in a gym or sports club rather than elsewhere. Thus, in contrast to earlier studies, we are able to investigate a person's commitment demand across different decision contexts (personal finances and exercising).

Specifically, we consider people's take-up of committed—often government-subsidized—plans designed to increase private savings. These include a range of products such as personal pension plans, bank savings plans, cash value life insurance, etc. Those who participate commit to having monthly contributions automatically deducted from their income rather than proactively making savings contributions themselves. Fees are levied and in some cases government-subsidies are withdrawn if the agreed savings plan is ended early or if contributions are too low. These plans incur large administrative fees. For all of these reasons, the savings plans we study are best characterized as commitment devices rather than standard financial investments. Our expectation is that those who are sophisticated rather than naïve about their self-control issues will be more likely to have a committed savings plan. Given that there are other available financial investments with comparable or even higher returns at similar risk,

we have no reason to expect people without self-control problems to be more likely than their naïve or sophisticated counterparts to have a committed savings plan.

We turn now to consider the link between sophistication and the way people exercise. Given our interest in commitment, our focus is on exercising that predominantly occurs out of a desire for good health and fitness rather than other motives. This allows us to investigate exercise that constitutes a health investment rather than a consumption good. Gym and sports club memberships may function as commitment devices for people who prefer to pay upfront to ensure they exercise regularly. Flat-rate plans reduce the marginal per-visit cost when going to the gym; however, the literature commonly finds that people locking themselves into long-term gym contracts ex-post overpay per visit (e.g., DellaVigna and Malmendier, 2006; Garon et al., 2015). This leads to two observations about the nature of self-control. First, naïfs may ex-ante overestimate their gym attendance making a gym membership seem cost effective. At the same time, however, they may be unwilling to pay for a gym membership believing that they do not require the commitment that it would provide. Second, those who are sophisticated may be happy to pay for the commitment that gym or sports club memberships involve by accepting higher fees. Consequently, we expect that sophistication is likely to be associated with increased exercising in a gym or sports club.

Mean outcomes by self-control type are reported in Table 6, while the estimated effect (in absolute and relative terms) of having a self-control problem (columns 1 and 2) and being sophisticated (columns 3 and 4) can be found in Table 9. As before, the p-value reported in column 5 of Table 9 refers to the overall effect of being sophisticated as opposed to time-consistent. Consistent with expectations, having a self-control problem does not affect the take-up of committed savings plans per se; $\hat{\alpha}_1$ is small in magnitude and statistically insignificant. However, people's sophistication about their self-control problems is associated with a 12.2 pp. (45.3 percent) increase in the probability of participating in a committed savings plan. Consequently, those who are sophisticated are significantly more likely than those who are naïve or time-consistent to have such plans.

Self-control also has no significant effect on the chances of exercising in a gym or sports club for health reasons, suggesting that there is no difference in commitment take-up by those who are naïve rather than time-consistent. As expected, however, people who are sophisticated are

4.9 pp. (48.3 percent) more likely to exercise in a gym or club compared to those who are naïve. They are also significantly more likely (3.5 pp. or 34.1 percent) to exercise in a gym or sports club rather than elsewhere when compared to people who are time-consistent. Importantly, this disparity is not driven by differences in the chances that sophisticated and time-consistent individuals engage in exercise for health reasons overall. The sophistication effect completely compensates for the self-control effect in health-related exercising (see Section 5.2), resulting in sophisticated and time-consistent individuals undertaking similar amounts of exercise to improve their health. Those who are sophisticated are more likely, however, to use a gym or sports club when exercising to improve their health. This provides strong evidence that sophisticates use gym and sports club memberships as a commitment device to achieve their exercising goals; time-consistent individuals are able to achieve the same levels of exercising without these memberships.

5.5 Sensitivity Analyses

We turn now to considering the robustness of our conclusions regarding: (i) our sample restrictions; (ii) the margin of error we allow for in achieving weight goals; and (iii) non-linear model specifications.

First, we relax all of our sample restrictions and re-estimate equation (2) using the full sample of 1,692 individuals with complete body weight information (see Appendix Table A8). Our main findings remain largely unaltered.

Second, when classifying individuals into self-control types, we have allowed for a two percent margin of error in determining whether people have met their weight loss goals. We investigate the sensitivity of our results to this choice by calculating the distribution of self-control types at margins of error between zero and five percent (see Appendix Figure A6). In addition, Appendix Figure A8 plots the estimated coefficients of self-control problems and sophistication along varying margins of error. In the case of education (years of education and college entrance degree) and savings (monthly precautionary savings), both the present-bias and sophistication effects are statistically significant and remarkably stable across varying degrees of prediction error. Similarly, sophistication has a positive and statistically significant effect on the use of committed savings plans as a commitment device regardless of the margin of error we allow. Our point estimates appear somewhat more volatile, but are robust up to a margin of error of

three percent in the case of exercising behavior in a gym or sports club for health reasons. At higher error margins, estimated effects become smaller, which is unsurprising given that the classification of people into self-control types blurs as the margin of error increases.

Third, for all discrete outcomes, we estimate probit regressions instead of linear probability models. The results are highly robust (see Appendix Table A9). Taken together, the results of these sensitivity analyses indicate that our substantive conclusions are not being driven by the specific modelling choices that we have made.

5.6 Partial Sophistication

Thus far, our analysis has focused on a discrete classification of people into three distinct self-control types: time-consistent, naïve, and sophisticated (see Figure 1). Those categorized as naïve are completely unaware of their time-inconsistency, while those with any awareness of their self-control issues are categorized as sophisticated. The group of sophisticates is likely to be quite heterogeneous however, since people can differ considerably in how aware they are of their self-control problems. Many may recognize that they struggle with self-control, but fail to fully understand the extent of the problem. Accounting for this heterogeneity has the potential to enrich our understanding of the consequences of people's sophistication.

Following Augenblick and Rabin (2019), we construct an intuitive measure of partial sophistication that is based on the share of a person's self-control problem that she is aware of. Its counterpart, i.e., the share of the self-control gap a person is naïve about, can be interpreted as a measure of partial naïveté. Specifically, we define partial sophistication as the share of the weight gap (2018 actual versus ideal) that people correctly predict:

$$\text{Sophistication}_i = \frac{\texttt{predicted}_i - \texttt{ideal}_i}{\texttt{weight 2018}_i - \texttt{ideal}_i}. \tag{3}$$

In equation (3), the weight gap is used to proxy the extent of people's self-control problems. Because people's realized body weight reflects their degree of sophistication as well as their capacity for self-control, our weight gap measure does not strictly align with the extent of self-control problems as discussed in O'Donoghue and Rabin (1999). Nonetheless, it provides an intuitive empirical approach to quantifying people's overall self-control capacity.[28]

[28]Our weight-based approach to constructing a typology of self-control types has the advantage that it is easily implemented in large-scale nationally representative surveys, adding important empirical evidence to the behavioral economics literature. At the same time, because people's body weight reflects the cumulative

We now turn to investigate how people's choices vary with their degree of sophistication and how much sophistication is required to overcome the penalties associated with poor self-control. Specifically, we analyze the marginal effect of partial sophistication using the following estimation model:

$$Y_i = \tilde{\alpha}_0 + \tilde{\alpha}_1 SCP_i + \tilde{\alpha}_2 AW_i Z_i \text{Sophistication}_i + \tilde{\alpha}_3 AW_i(1 - Z_i) + \boldsymbol{X}_i'\tilde{\boldsymbol{\gamma}} + \epsilon_i, \tag{4}$$

where as before SCP_i is an indicator for having a self-control problem that takes the value 1 if the individual is naïve or sophisticated, and 0 if the individual is time-consistent; AW_i is an indicator of awareness (sophistication) about one's self-control limitations that takes the value 1 if the individual is partially or fully sophisticated, and 0 if one is completely naïve or time-consistent. In addition, Z_i is an indicator that takes the value 1 if $\texttt{weight 2018}_i \geq \texttt{predicted}_i$, and 0 otherwise; allowing us to account separately for sophisticates who overachieve their predicted weight goals.[29] Given this specification, $\tilde{\alpha}_1$ can be interpreted as the effect of having a self-control problem for both naïfs and sophisticates as before (see equation (2)). The marginal effect of additional sophistication on people's outcomes is captured by $\tilde{\alpha}_2$. It is estimated using only those sophisticates whose degree of sophistication is between 0 and 1 (i.e., those who achieve at most their predicted weight loss). The differential effect of achieving a greater weight loss than expected (relative to people with self-control problems but no sophistication) is captured by $\tilde{\alpha}_3$. Finally, Y_i and vector $\boldsymbol{X}_i'$ are defined as in equation (2), and ϵ_i is an error term.

Our estimation results are reported in Table 10. Although people's self-control problems are associated with a reduced tendency to choose options that are immediately costly with long-run benefits, increases in their degree of sophistication mitigate this. In the case of education, for example, the average self-control penalty is completely offset for those who predict around half

effects of repeated choices rather than a single decision, we cannot empirically isolate the self-control and sophistication effects in a way that is completely sympathetic with the theoretical foundations in O'Donoghue and Rabin (1999) when moving beyond a binary to a continuous classification of people. Augenblick and Rabin (2019), in contrast, focus solely on a single predicted future behavior implying that their experimental measure of partial sophistication is not confounded by the sophistication effect per se. It is, however, affected by the fact that subjects aim at behaving consistently with their incentivized predictions of own future behavior. In contrast, survey-based measures of sophistication require future behavior to be verifiable, though not necessarily incentivized.

[29] In our data, 23.3 percent of sophisticates weigh less in 2018 than they expected to weigh. It is difficult to conceptualize the degree of sophistication for these individuals. Consequently, we take a conservative approach and control for them directly rather than including them in estimates of $\tilde{\alpha}_2$. Excluding these individuals from the estimation sample leads to similar results.

(46.5 percent) or more of their weight gap (see column 3). The degree of sophistication required to overcome the average self-control penalty is even smaller in the case of getting a college degree (39.3 percent) and saving regularly each month (11.6 percent). Given that the average degree of sophistication among the sophisticates in our sample is 65.5 percent, it appears that many sophisticates are able to overcome the average consequences of having a self-control problem when making education and savings decisions. At the same time, it requires a great deal of sophistication to overcome the negative effect that limited self-control has on people's decision to exercise. Even those who are fully sophisticated are estimated to exercise less than those who have no self-control problems, although this difference is not statistically significant.

Quantifying the extent of people's partial sophistication is less helpful in understanding choices involving immediate benefits with long-term costs. Neither the self-control problem itself nor the degree of sophistication is estimated to have a significant relationship with people's decisions to consume alcohol or tobacco or to oversleep. Taken together, our results provide no evidence that increasing sophistication supports people in avoiding choices that may be immediately pleasurable, but have long-term costs. If anything, sophistication appears in most cases to reinforce the effects of limited self-control.

Increasing sophistication is, however, associated with an increased likelihood that people take up commitment devices such as savings plans and exercising in a gym. This effect is not only statistically significant, but also economically important. Being fully sophisticated versus completely naïve about their weight gap is associated with a 13.9 pp. (51.4 percent) increase in the probability that people have a savings plan and a 6.3 pp. (61.8 percent) increase in the likelihood they exercise in a gym.

Finally, results for those who overachieve their expected weight loss goal (i.e., those who weigh less in 2018 than they predicted they would) are given in column 4 of Table 10. The direction of coefficients is generally the same as for the degree of sophistication. As this group is small however, estimation precision is lower. Thus, in most cases, their choices do not differ statistically significantly from people who have self-control problems but no sophistication. The exception is that overachievers without a mortgage are 13.7 pp. (23.9 percent) more likely to save regularly each month and 11.2 pp. (41.6 percent) more likely to have a committed savings plan.

5.7 Naïveté and Overconfidence

In their recent handbook chapter on inter-temporal choice, Ericson and Laibson (2019) point to a number of open questions about the role of present-focus and naïveté versus other explanations like overconfidence for understanding why people underestimate their own tendency to procrastinate. They also emphasize how difficult it is in practice to distinguish among competing types of incorrect beliefs such as naïveté and overconfidence. Our data allow us to cast light on this issue by first considering a simple and intuitive overconfidence measure; and second, relating it to our measure of partial sophistication. Our focus is on absolute overconfidence which generally refers to the extent to which a person's views about their own performance (or some characteristic) is more positive than justified by its actual realization.

Consequently, we construct a measure of overconfidence by taking the difference between actual 2018 weight and the weight predicted in 2017 for 2018 and normalizing by actual 2018 weight. Specifically,

$$\text{Overconfidence}_i = \frac{\texttt{weight 2018}_i - \texttt{predicted}_i}{\texttt{weight 2018}_i}. \tag{5}$$

In effect, the more that actual 2018 weight exceeds the weight predicted for 2018, the more overconfident a person is considered to be.[30] Since our measure of overconfidence is constructed using beliefs that refer to the same (body weight) domain that we use to measure relative sophistication, the following straightforward relation between naïveté and overconfidence holds:

$$\text{Overconfidence}_i = \text{Naïveté}_i \times \frac{\texttt{weight 2018}_i - \texttt{ideal}_i}{\texttt{weight 2018}_i}, \tag{6}$$

where $\text{Naïveté}_i = 1 - \text{Sophistication}_i$ corresponds to the portion of people's weight gap that they fail to predict. As before, people's weight gap is used to proxy their self-control problems. The second right-hand-side term expresses people's self-control limitations as a percent of their body weight. Thus, in effect, overconfidence corresponds to the share of one's self-control problems that one is naïve about.

[30] Figure 6 plots the distribution of overconfidence, illustrating that people make highly variable prediction errors. Consistent with previous studies (e.g., Chen and Schildberg-Hörisch, 2019; Moore and Healy, 2008), more individuals (58 percent) are overconfident than well-calibrated or underconfident (21 percent each).

More generally, naïveté and overconfidence are related because both reflect incorrect beliefs. They are conceptually distinct, however, in one important respect. Defining the extent of naïveté about own self-control problems requires that we understand what people consider to be the ideal outcome for themselves so that we are able to detect self-control failures. In contrast, the concept of overconfidence refers to incorrect beliefs about one's realized outcomes (or characteristics) more generally, irrespective of whether or not they are ideal. Thus, simply observing the extent to which people over-estimate their actual future weight loss is, in and of itself, not sufficient to identify their degree of naïveté.

This makes the relationship between naïveté and overconfidence an empirical issue. As expected, we find a positive relationship between overconfidence and the extent to which people are unaware of their own self-control problems. Those we classify as naïve are more overconfident than those who are at least partially sophisticated. On average, naïfs' actual 2018 weight is 6.8 percent higher than what they predicted it would be, while sophisticates' actual weight is only 2.4 percent higher than predicted.[31] The Pearson correlation between the overconfidence and naïveté measures is positive (0.416) and significantly different to zero ($p = 0.00$).[32] Importantly, this correlation is also significantly different to one ($p = 0.00$) indicating that, while people's overconfidence contributes to their naïveté about their own self-control problems, overconfidence and naïveté are far from perfectly correlated.

6 Conclusions

Economists' conceptual understanding of the importance of sophistication in inter-temporal choice has far outstripped their empirical understanding. Our research contributes to closing this gap by introducing a novel, survey-based strategy for measuring people's time-inconsistency and sophistication that is theoretically grounded in behavioral models such as O'Donoghue and Rabin (1999, 2001). Importantly, we estimate time-inconsistency and sophistication using consequential inter-temporal consumption decisions as reflected in people's body weight, which is a key advantage over methods that rely on time-dated monetary payments (see Augenblick

[31] To account also for small deviations, we no longer allow for a margin of error in classifying people's self-control types. By definition, overconfidence is close to zero (−1.8 percent) for those who are time-consistent.

[32] The correlation is calculated using the sample of all naïfs (setting $Sophistication_i = 0$) and sophisticates who do not overachieve their predicted weight goals ($0 < Sophistication_i \leq 1$). Thus, time-consistents and overachieving sophisticates are excluded.

et al., 2015). Our approach allows us to provide more direct evidence on sophistication than studies that infer sophistication from the take-up of commitment devices. We are also able to avoid any threats to internal validity associated with possible experimenter demand effects in experimental studies of commitment device take-up.

Using nationally representative data, we demonstrate that self-control problems are pervasive—only about one-third of the population behave in a time-consistent manner, underscoring the potential for self-control problems to result in serious welfare losses. Among everyone else, slightly more than half are at least partly aware of their self-control problems. The rest are completely naïve.

Our results shed light on key aspects of behavioral economic theory. First, resolving the theoretical ambiguity around both the direction and magnitude of the sophistication effect requires sound empirical evidence. We demonstrate that being sophisticated has generally positive and, in many cases, sizeable, consequences for people's health and wellbeing. In the case of investments involving immediate costs with future benefits, being sophisticated fully compensates for the penalties associated with having limited self-control. This is an important finding that argues for an expanded set of policy options in supporting people to overcome the adverse consequences of self-control failures. Although previous policies target a reduction in self-control problems themselves,[33] an equally promising strategy may be to raise people's awareness of their own limited capacity for self-control.

Second, consistent with theoretical predictions (e.g., Fudenberg and Levine, 2006; Gul and Pesendorfer, 2001; Laibson, 1997; O'Donoghue and Rabin, 1999), sophisticated individuals are more likely to take up commitment devices that support them in achieving their goals. An important difference of our approach compared to previous evidence on the take-up of commitment devices is that we do not infer sophistication from take-up, but use an independent measure of sophistication to test this key theoretical prediction of behavioral models of sophistication. Third, although people's overconfidence contributes to their naïveté about their self-control limitations, naïveté and overconfidence are conceptually and empirically distinct,

[33]Numerous programs to enhance children's self-control and related skills have been developed and positively evaluated (see Alan et al., 2019; Alan and Ertac, 2018; Sorrenti et al., 2020, and the meta-analyses on self-control interventions for children under the age of 10 by Piquero et al., 2010, 2016). We are unaware of direct evidence showing the effect of early childhood interventions on measures of time preference and time-inconsistency based on experiments using time-dated monetary payments or real consumption choices.

answering a key question about theories of inter-temporal choice (see Ericson and Laibson, 2019).

There is a pressing need to know more about whether—and if so, how—people can learn about their capacity for self-control. Our results indicate that, compared to naïveté, sophistication is associated with having higher levels of both crystallized and fluid intelligence as well as more educated parents. All of these may strengthen the capacity for self-reflection. However, we also find that sophisticates' BMI is significantly higher, adding weight to previous evidence that sophisticates may be more present-biased than are naïfs (Cerrone and Lades, 2017; Mahajan et al., 2020). This leads us to speculate that people's awareness of their own self-control limitations may increase the more consequential and predictable those limitations become. At the same time, behavioral theory predicts that sophisticates may make choices that compound their self-control issues, making it difficult to isolate the direction of causality. Either way, there is a need to move beyond the usual behavioral theory framework to develop new models that allow sophistication to be endogenously formed, perhaps through prior learning as in Ali (2011). Ultimately, the successful design of policy interventions targeting people's awareness of their self-control issues depends on developing a deeper understanding of how malleable sophistication is, and the process through which people come to understand their own self-control issues.

Finally, it is striking that measures of time-inconsistency and sophistication elicited in the body weight domain predict not only exercising, a key health-related behavior, but also educational attainment and financial decision-making. To some extent at least, time-inconsistency and sophistication appear to be domain-general rather than domain-specific individual traits. The predictive power of our measures across domains beyond body weight is proof of concept. Our classification approach has the potential to be used more broadly to empirically investigate the consequences of self-control and sophistication for people's wellbeing. In our view, Augenblick et al. (2015, p. 1113) are correct in stating that: "Ultimately, the best measure of time inconsistency will be one that predicts ecologically relevant decisions across a broad set of environments."

Tables and Figures

Table 1: Characterization of self-control types

Self-control	Types	Model parameters	Choices
No self-control problems	Time-consistent	$\hat{\beta} = \beta = 1$	ideal = predicted = actual
Self-control problems	Naïve	$\beta < 1 = \hat{\beta}$	ideal = predicted $\neq$ actual
	(Fully) Sophisticated	$\hat{\beta} = \beta < 1$	ideal $\neq$ predicted = actual
	Partially naïve	$\beta < \hat{\beta} < 1$	ideal $\neq$ predicted $\neq$ actual

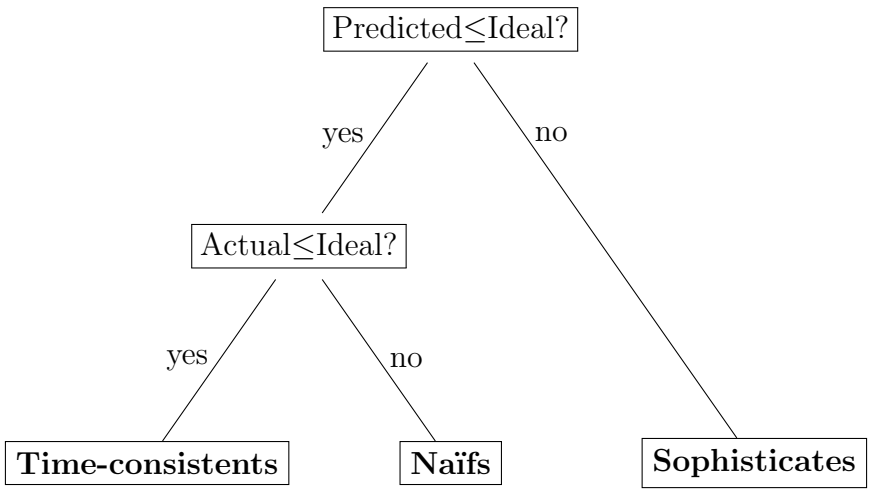
Notes: As a special case, actual and ideal behavior may also coincide for fully sophisticated individuals if the present-bias and sophistication effect cancel each other out.

Table 2: Survey questions on body weight

Question	Survey year in SOEP-IS
What is your current body weight in kg?	2017
What weight (in kg) do you view as ideal for yourself at the time of the next interview in approximately one year?	2017
What weight (in kg) do you expect to have at the time of the next interview in approximately one year?	2017
What is your current body weight in kg?	2018

Notes: SOEP-IS questionnaires 2017 and 2018. Questions were asked in this order.

Figure 1: Type classification tree

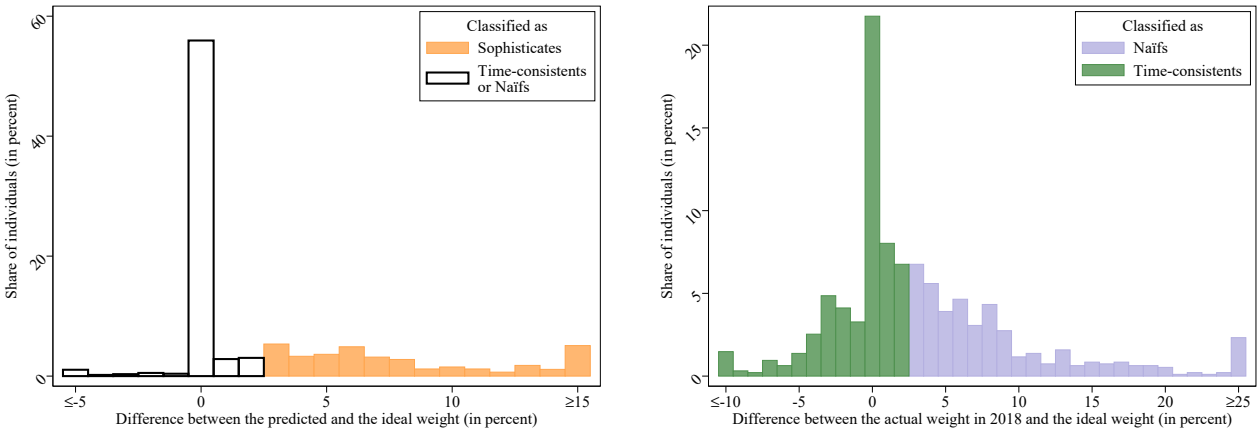


Notes: Own illustration. "Predicted" refers to weight individuals expect to have in 2018 (surveyed in 2017), "Ideal" to weight individuals report as their ideal weight (surveyed in 2017), and "Actual" to weight individuals have in 2018 (surveyed in 2018). Our empirical implementation of this tree allows for a margin of error in meeting the required inequalities.

Figure 2: Distribution of weight differences and classification of self-control types

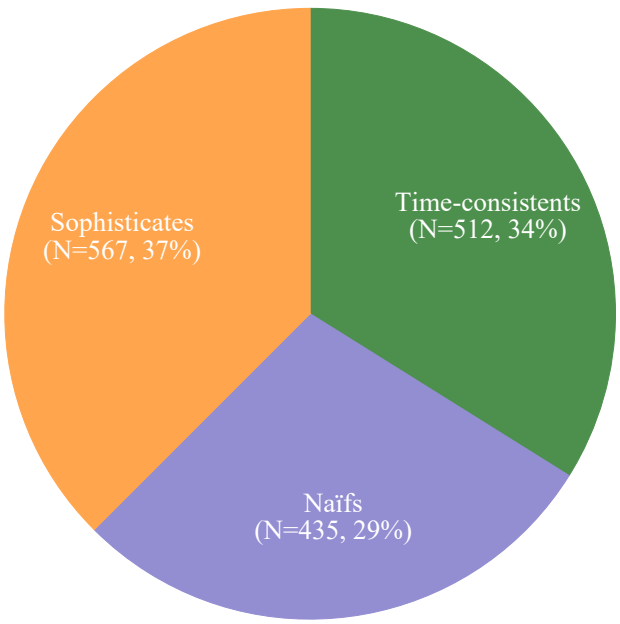
(a) First node: $\frac{\text{predicted}-\text{ideal weight}}{\text{ideal weight}}$

(b) Second node: $\frac{\text{weight 2018}-\text{ideal weight}}{\text{ideal weight}}$ (only for naïfs and time-consistents)



Notes: SOEP-IS analysis sample. Observations: 1,514 for plot (a) and 947 for plot (b). First and second node refer to position in the classification tree in Figure 1, where the respective weight difference (that is displayed relative to ideal weight) is relevant for the type distinction.

Figure 3: Type distribution



Notes: SOEP-IS analysis sample, 1,514 observations. Margin of error of ±2 percent relative to ideal weight.

Table 3: Evidence on the share of time-consistent, sophisticated, and naïve individuals

Study	Sample	Classification based on	Share (in percent) Time-consistents	Naïfs	Sophisticates
Our results	1,514 repres. individuals	body weight	34	29	37
Previous studies					
Wong (2008)[a]					
– Sample 1	158 university students	study hours	13	14	73
– Sample 2	287 university students	study hours	8	21	71
Mandel et al. (2017)					
– Study 1A	205 university students	study hours	19	11	70
– Study 1B	290 university students	study hours	39	25	36
– Study 2	218 university students	consumption of unhealthy food	12	58	31
– Study 3	164 university students	study hours	38	17	45
Cerrone and Lades (2017)[b]	125 university students	Convex Time Budgets, survey question	33	25	42
Mahajan et al. (2020)	566 households	choices of commitment product, experiment time preference	21	49	30

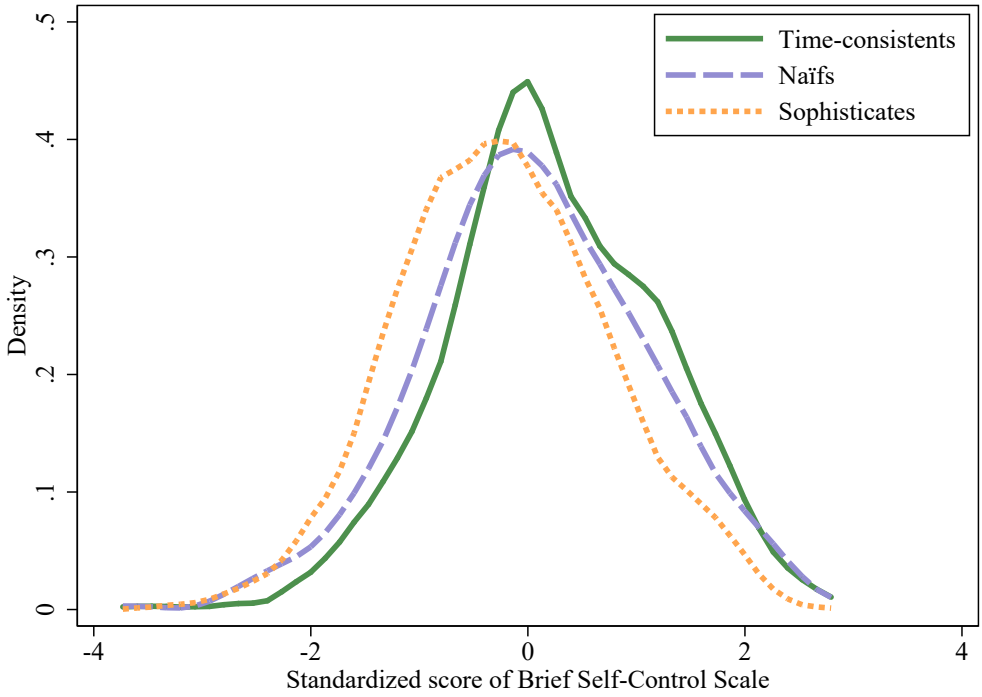
Notes: [a]For Wong (2008), we report the shares that allow for small perturbations that are similar to our margin of error. [b]In Cerrone and Lades (2017), 42% of individuals are classified as future-biased; the numbers in this table refer to shares among the remaining subjects. Several further studies provide some information on individual types but do not match all three types: Kuchler and Pagel (2021) classify about half of their sample as naïve and half as sophisticated. Augenblick and Rabin (2019) estimate between 10 and 18% of subjects to be time-consistent and document low degrees of sophistication. In Ameriks et al. (2007), the joint share of time-consistents and naïfs amounts to about 70%.

Table 4: Characteristics by self-control type

Variable	Variable mean for: Time-consistents (1)	Naïfs (2)	Sophisticates (3)	Test equality of means: TC=N (4)	N=S (5)	TC=S (6)	Number of Obs. (7)
Demographic characteristics							
Age	58.82	53.20	51.32	**0.00**	0.09	**0.00**	1,514
Female	0.51	0.50	0.54	0.70	0.25	0.43	1,514
Lived in 1989: East Germany	0.24	0.17	0.23	**0.01**	**0.03**	0.68	1,413
Dad: > basic school	0.29	0.27	0.32	0.54	0.07	0.22	1,514
Mom: > basic school	0.30	0.28	0.35	0.45	**0.02**	0.09	1,514
Number of siblings	2.08	2.06	1.90	0.87	0.16	0.10	1,514
Migrational background	0.07	0.10	0.10	0.19	0.92	0.19	1,514
Religion: catholic	0.25	0.28	0.27	0.33	0.72	0.50	1,514
Religion: protestant	0.36	0.31	0.31	0.07	0.89	0.07	1,514
Body weight 2017	72.83	80.43	84.49	**0.00**	**0.00**	**0.00**	1,514
Body height	170.91	171.37	171.67	0.45	0.61	0.18	1,513
Cognitive skills, economic preferences, and other personality traits							
Fluid intelligence	-0.10	-0.02	0.11	0.24	0.05	**0.00**	1,315
Crystallized intelligence	0.15	-0.16	-0.01	**0.00**	**0.03**	**0.01**	1,335
Openness	0.12	0.03	-0.13	0.21	**0.01**	**0.00**	1,507
Conscientiousness	0.13	0.08	-0.18	0.40	**0.00**	**0.00**	1,510
Extraversion	-0.01	0.04	-0.02	0.45	0.41	0.96	1,512
Agreeability	0.11	0.01	-0.11	0.12	0.06	**0.00**	1,513
Emotional stability	0.10	0.03	-0.12	0.26	**0.02**	**0.00**	1,512
Risk tolerance	-0.08	0.13	-0.04	**0.03**	0.07	0.71	680
Patience	0.08	0.07	-0.13	0.93	**0.00**	**0.00**	1,384
Brief Self-Control Scale	0.23	0.05	-0.23	**0.01**	**0.00**	**0.00**	1,441

Notes: SOEP-IS analysis sample, varying number of observations (see column 7). All demographic characteristics are indicator variables, with the exception of age (in years), number of siblings, and body height (in cm) and weight (in kg); preferences, personality traits, and abilities are in standard deviations. TC=time-consistents, N=naïfs, S=sophisticates. Means of variable by self-control type (columns 1 to 3); p-values of corresponding pairwise tests for equality of means between the two groups (H_0; columns 4 to 6). Bold p-values indicate statistical significance at 5% level. For variable definitions, see Appendix Table A1.

Figure 4: Distributions of Brief Self-Control Scale scores by type



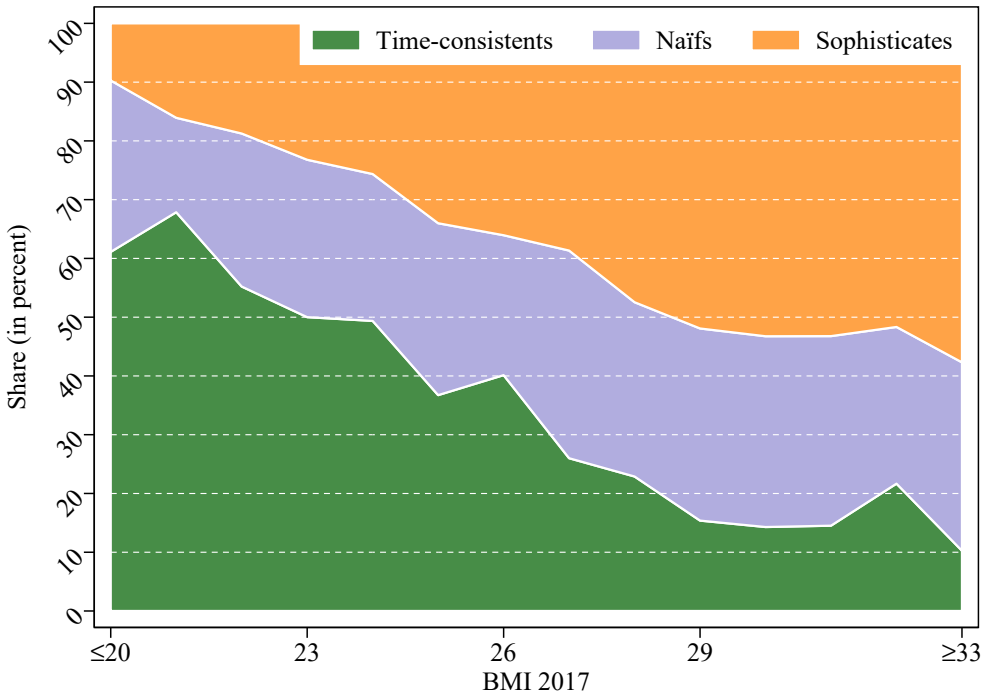
Notes: SOEP-IS analysis sample, 1,441 observations. Kolmogorov-Smirnov test of equality of distributions (H_0, decision at 5% level): time-consistents vs. naïfs: H_0 cannot be rejected (p-value 0.11); naïfs vs. sophisticates: H_0 can be rejected (p-value 0.01); time-consistents vs. sophisticates: H_0 can be rejected (p-value 0.00).

Table 5: Body Mass Index (BMI) by self-control type

		BMI			
		in '17 (1)	in '18 (2)	ideal (3)	predicted (4)
Male	Naïfs	27.9	28.5	26.5	26.5
Male	Sophisticates	29.3	29.1	26.3	28.6
Male	Time-consistents	25.5	25.1	25.3	25.3
Female	Naïfs	26.7	27.3	24.8	24.8
Female	Sophisticates	28.0	28.0	24.7	27.1
Female	Time-consistents	24.2	23.8	24.0	23.9

Notes: SOEP-IS analysis sample, 1,512 observations. Average BMI by gender and self-control type, calculated based on weight in 2017 (column 1), weight in 2018 (column 2), ideal weight (column 3), or predicted weight for 2018 (column 4).

Figure 5: Type distribution along BMI in 2017



Notes: SOEP-IS analysis sample, 1,513 observations. We pool observations with BMI $\leq$ 20 and with BMI $\geq$ 33 to ensure that we have at least 50 observations for each plotted value of BMI.

Table 6: Summary statistics of outcome variables by self-control type

	Variable mean for				
Variable	Over-all (1)	Time-consistents (2)	Naïfs (3)	Sophisti-cates (4)	Number of Obs. (5)
Choices involving immediate costs and later benefits					
Years of education	12.62	12.94	12.14	12.69	1,491
College entrance degree	0.38	0.43	0.32	0.38	1,501
Exercise for health reasons	0.22	0.28	0.18	0.21	1,514
Any monthly savings	0.59	0.57	0.57	0.62	1,514
– No mortgage	0.57	0.56	0.53	0.62	1,136
Choices involving immediate benefits and later costs					
Alcohol: 4+ days a week	0.18	0.21	0.17	0.17	1,423
Alcohol: 3+ drinks	0.31	0.24	0.32	0.35	1,222
Smoking	0.22	0.20	0.22	0.24	1,513
Oversleeping	0.34	0.29	0.32	0.41	638
Take up of commitment devices					
Savings plan	0.27	0.22	0.22	0.35	1,514
Exercise in gym/sports club	0.10	0.11	0.07	0.11	1,514

Notes: SOEP-IS analysis sample, varying number of observations (see column 5). Unconditional mean (column 1) and means of variable by self-control type (columns 2 to 4). Variables are defined in Appendix Table A1.

Table 7: Estimation results for choices involving immediate costs and later benefits

	Effect of self-control problem ($\hat{\alpha}_1$)		Effect of sophistication ($\hat{\alpha}_2$)		Test	
Outcome variable	coef. (1)	rel. size (2)	coef. (3)	rel. size (4)	$\hat{\alpha}_1 = -\hat{\alpha}_2$ (5)	R^2 (6)
Years of education	-0.422^{**}	-0.033	0.529^{***}	0.042	0.54	0.16
	(0.180)		(0.171)			
College entrance degree	-0.059^{*}	-0.155	0.079^{**}	0.208	0.53	0.10
	(0.033)		(0.031)			
Exercise for health reasons	-0.055^{*}	-0.245	0.045	0.200	0.72	0.04
	(0.029)		(0.027)			
Any monthly savings	-0.059	-0.100	0.084^{*}	0.143	0.51	0.01
	(0.044)		(0.044)			
– No mortgage	-0.083^{*}	-0.145	0.120^{**}	0.209	0.42	0.01
	(0.049)		(0.050)			

Notes: SOEP-IS analysis sample, OLS estimations. Number of observations are 1,491 (years of education), 1,501 (college entrance degree), 1,514 (exercise for health reasons), 1,514 (any monthly savings), 1,136 (any monthly savings, no mortgage). All estimations control for gender, first- and second-generation migrational background, number of siblings, 2017 weight, height, and patience, as well as a maximum set of fixed effects for state of residence, year of birth, interview month, and a constant; see Appendix Table A1 for details on the definitions of all variables. Coefficient of self-control problem indicator in absolute (column 1) and relative terms (divided by outcome variable's unconditional mean, column 2); coefficient of sophistication indicator in absolute (column 3) and relative terms (column 4); p-value of test for $H_0 : \hat{\alpha}_1 = -\hat{\alpha}_2$ (column 5); adjusted R^2 (column 6). For any monthly savings, self-control and sophistication indicators are based on type of both spouses for couple-headed households. Standard errors are given in parentheses and are clustered at household level for any monthly savings. The underlying p-values of $\hat{\alpha}_1$ are 0.02 for years of education, 0.07 for college entrance degree, 0.06 for exercise for health reasons, 0.18 for any monthly savings, and 0.09 for any monthly savings when no mortgage has to be paid back. For $\hat{\alpha}_2$ they are (in the same order): 0.00, 0.01, 0.10, 0.06, and 0.02. Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 8: Estimation results for choices involving immediate benefits and later costs

	Effect of self-control problem ($\hat{\alpha}_1$)		Effect of sophistication ($\hat{\alpha}_2$)		Test	
Outcome variable	coef. (1)	rel. size (2)	coef. (3)	rel. size (4)	$\hat{\alpha}_1 = -\hat{\alpha}_2$ (5)	R^2 (6)
Alcohol: 4+ days a week	0.000	0.000	-0.002	-0.009	0.95	0.10
	(0.027)		(0.026)			
Alcohol: 3+ drinks	0.017	0.057	0.021	0.068	0.25	0.11
	(0.034)		(0.033)			
Smoking	-0.014	-0.062	0.005	0.025	0.77	0.06
	(0.028)		(0.027)			
Oversleeping	0.030	0.088	0.035	0.103	0.21	0.07
	(0.051)		(0.049)			

Notes: SOEP-IS analysis sample, OLS estimations. Number of observations are 1,423 (alcohol: 4+ days a week), 1,222 (alcohol: 3+ drinks), 1,513 (smoking), 638 (oversleeping). All estimations control for gender, first- and second-generation migrational background, number of siblings, 2017 weight, height, and patience, as well as a maximum set of fixed effects for state of residence, year of birth, interview month, and a constant; see Appendix Table A1 for details on the definitions of all variables. Coefficient of self-control problem indicator in absolute (column 1) and relative terms (divided by outcome variable's unconditional mean, column 2); coefficient of sophistication indicator in absolute (column 3) and relative terms (column 4); p-value of test for $H_0 : \hat{\alpha}_1 = -\hat{\alpha}_2$ (column 5); adjusted R^2 (column 6). Standard errors are given in parentheses. The underlying p-values of $\hat{\alpha}_1$ are 1.00 for extensive margin of drinking, 0.62 for intensive margin of drinking, 0.63 for smoking, and 0.56 for oversleeping. For $\hat{\alpha}_2$ they are (in the same order): 0.95, 0.53, 0.84, and 0.47. Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 9: Estimation results for take-up of commitment devices

	Effect of self-control problem ($\hat{\alpha}_1$)		Effect of sophistication ($\hat{\alpha}_2$)		Test	
Outcome variable	coef. (1)	rel. size (2)	coef. (3)	rel. size (4)	$\hat{\alpha}_1 = -\hat{\alpha}_2$ (5)	R^2 (6)
Savings plan	−0.023	−0.084	0.122***	0.453	0.00	0.10
	(0.035)		(0.038)			
Exercise in gym/sports club	−0.014	−0.142	0.049**	0.483	0.09	0.02
	(0.021)		(0.020)			

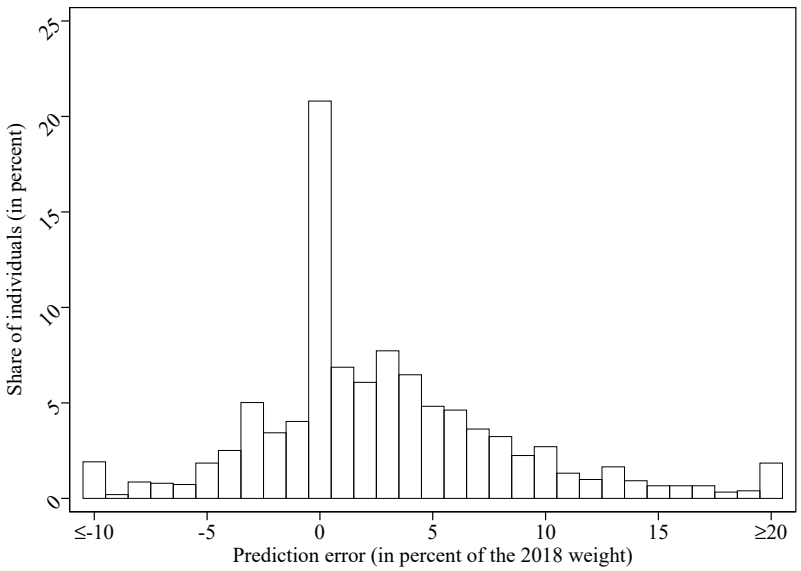
Notes: SOEP-IS analysis sample, OLS estimations. Number of observations are 1,514 (savings plan), 1,514 (exercise in gym/sports club). All estimations control for gender, first- and second-generation migrational background, number of siblings, 2017 weight, height, and patience, as well as a maximum set of fixed effects for state of residence, year of birth, interview month, and a constant; see Appendix Table A1 for details on the definitions of all variables. Coefficient of self-control problem indicator in absolute (column 1) and relative terms (divided by outcome variable's unconditional mean, column 2); coefficient of sophistication indicator in absolute (column 3) and relative terms (column 4); p-value of test for $H_0 : \hat{\alpha}_1 = -\hat{\alpha}_2$ (column 5); adjusted R^2 (column 6). For savings plan, self-control and sophistication indicators are based on type of both spouses for couple-headed households. Standard errors are given in parentheses and are clustered at household level for savings plan and home owing. The underlying p-values of $\hat{\alpha}_1$ are 0.52 for savings plan, 0.50 for exercise in gym/sports club. For $\hat{\alpha}_2$ they are (in the same order): 0.00, 0.01. Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 10: Estimation results considering the degree of sophistication

	Effect of	Degree of sophistication			
	self-control problem	between 0 and 1	break-even point	over-achievers	
	($\tilde{\alpha}_1$)	($\tilde{\alpha}_2$)	($-\tilde{\alpha}_1/\tilde{\alpha}_2$)	($\tilde{\alpha}_3$)	R^2
Outcome variable	(1)	(2)	(3)	(4)	(5)
Choices involving immediate costs at later benefits					
Years of education	-0.450^{**}	0.969^{***}	0.465	0.345	0.16
	(0.177)	(0.241)		(0.263)	
College entrance degree	-0.059^{*}	0.149^{***}	0.393	0.010	0.11
	(0.032)	(0.044)		(0.048)	
Exercise for health reasons	-0.048^{*}	0.039	> 1	0.048	0.04
	(0.028)	(0.039)		(0.042)	
Monthly savings	-0.011	0.098^{**}	0.116	0.068	0.01
	(0.035)	(0.048)		(0.053)	
– No mortgage	-0.020	0.118^{**}	0.170	0.137^{**}	0.01
	(0.042)	(0.057)		(0.061)	
Choices involving immediate benefits at later costs					
Alcohol: 4+ days a week	-0.004	0.032	0.134	-0.038	0.10
	(0.026)	(0.036)		(0.039)	
Alcohol: 3+ drinks	0.003	0.054	< 0	0.075	0.11
	(0.034)	(0.046)		(0.051)	
Smoking	-0.005	-0.010	< 0	-0.024	0.06
	(0.028)	(0.038)		(0.041)	
Oversleep weekly	0.044	0.046	< 0	-0.070	0.07
	(0.050)	(0.069)		(0.076)	
Take-up of commitment devices					
Savings plan	0.011	0.139^{***}	< 0	0.112^{**}	0.10
	(0.029)	(0.044)		(0.048)	
Exercise in gym/sport club	-0.012	0.063^{**}	0.192	0.049	0.02
	(0.021)	(0.028)		(0.031)	

Notes: SOEP-IS analysis sample, OLS estimations. Numbers of observations and specification as in Tables 7 to 9. Break-even point (column 3) is calculated as the degree of sophistication (between 0 and 1) necessary to exactly offset the self-control problem effect, i.e., $-\tilde{\alpha}_1/\tilde{\alpha}_2$; < 0 and > 1 indicate that the point is outside the 0 to 1 interval. Standard errors are given in parentheses and are clustered at household level for any monthly savings and savings plan. Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Figure 6: Distribution of the overconfidence measure



Notes: SOEP-IS analysis sample, 1,514 observations. About 21 percent of individuals are well-calibrated (weight 2018=predicted), 58 percent overconfident (weight 2018>predicted), and 21 percent underconfident (weight 2018<predicted).

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Sophistication about Self-Control

—Online Appendix—

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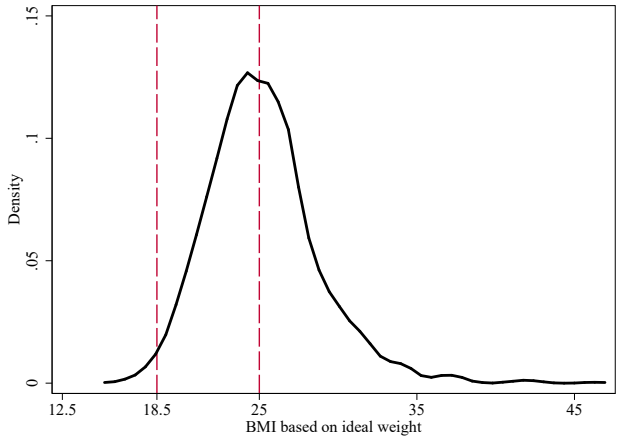
July 2021

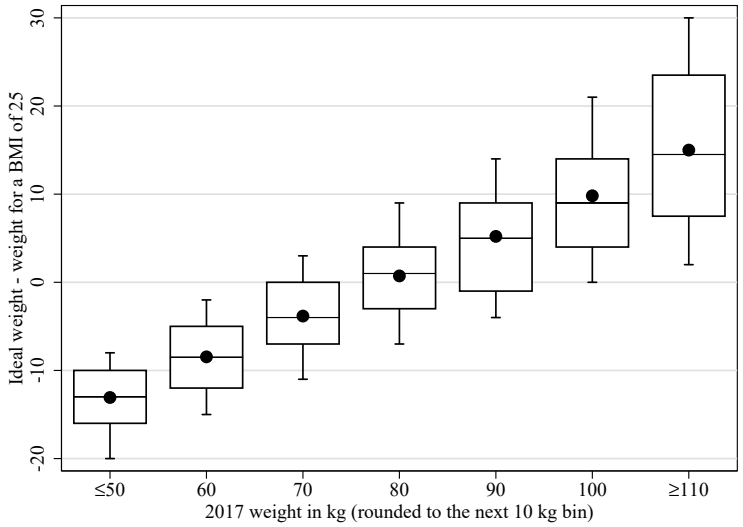
Online Appendix A Additional Results and Information

Figure A1: Subjective and medical ideal weight



Notes: SOEP-IS analysis sample, 1,513 observations. The vertical dashed red lines indicate the lower and upper limit of the medical ideal weight. The Kernel distribution function displays the BMI based on the subjective ideal weight.

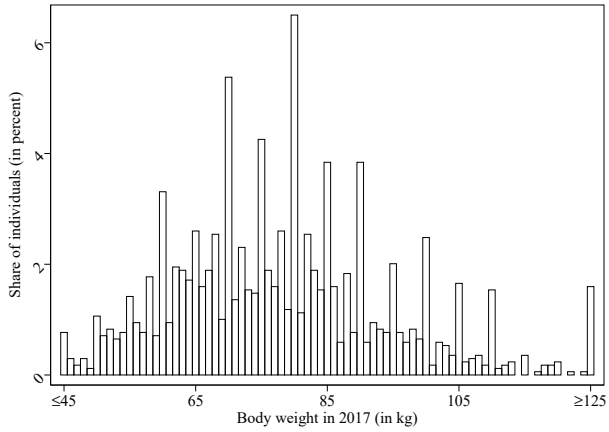
Figure A2: Subjective ideal weight increases in current weight



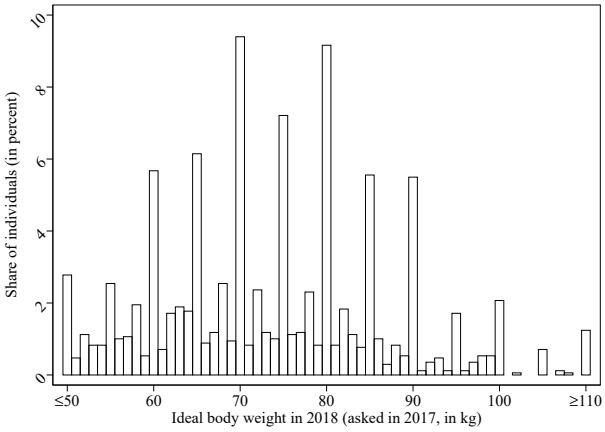
Notes: SOEP-IS analysis sample, 1,513 observations. Interpretation of box plot: upper hinge gives the 75th percentile of the self-reported ideal weight–BMI of 25 difference, the lower hinge the 25th percentile, the whiskers give the 90th and 10th percentiles, the horizontal line in the box gives the median, the marker gives the mean.

Figure A3: Distribution of body weight information

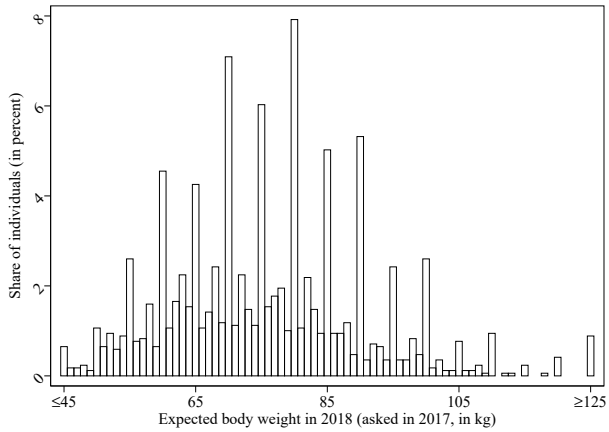
(a) Body weight 2017



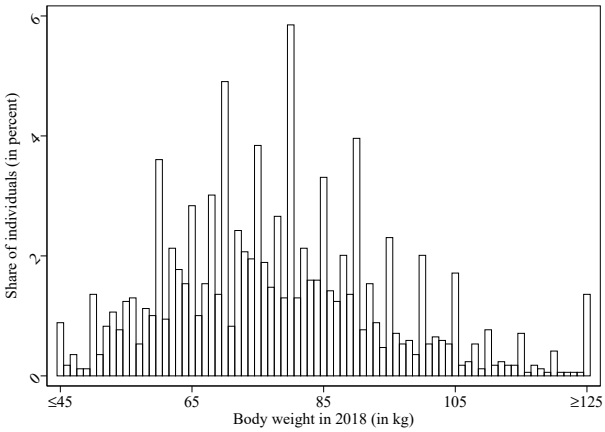
(b) Ideal body weight



(c) Predicted body weight



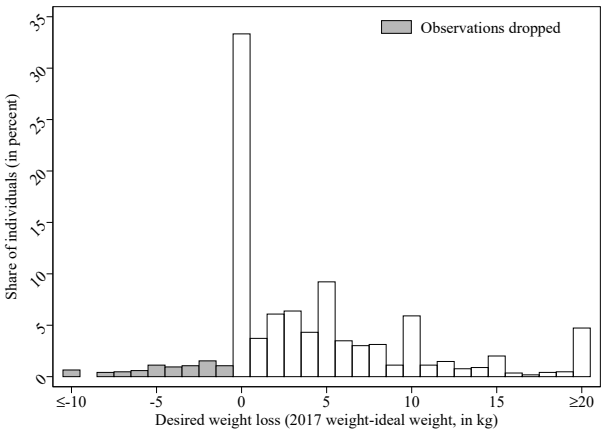
(d) Body weight 2018



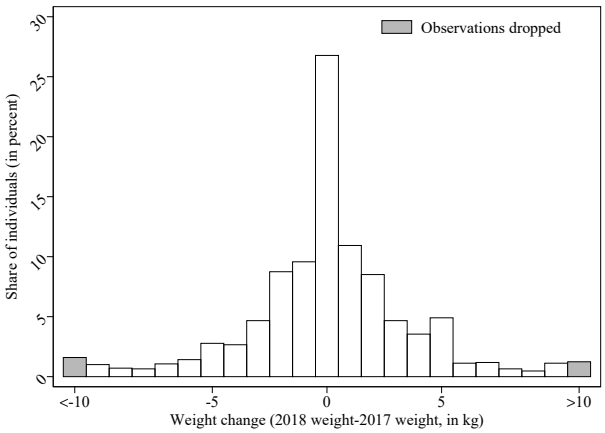
Notes: SOEP-IS full sample with available body weight information, 1,692 observations.

Figure A4: Distribution of weight differences and analysis sample

(a) Difference: weight 2017 − ideal weight



(b) Difference: weight 2018 − weight 2017



Notes: SOEP-IS full sample with available body weight information (1,692 observations) including dropped observations and analysis sample (1,514 observations).

Table A1: Variable definitions

Variable	Definition
Characteristics, Preferences, and Traits (Section 4.2)	
Demographic characteristics, 2017 weight and height	
Age (in years)	Respondent's age in years in 2017.
Female	=1 if respondent is female, 0 else.
Lived in 1989: East Germany	=1 if respondent's answer to the question "Where did you live before German reunification, that is, before 1989?" is "East Germany/East Berlin", 0 else. Missing if lived abroad or born after 1989.
Mom/Dad: > basic school	=1 if the highest school degree of respondent's mother/father is more than basic schooling (*Hauptschule*), 0 else.
Number of siblings	Number of the respondent's siblings.
Migrational background	=1 if a respondent was born outside of Germany or has at least one parent who was born outside of Germany, 0 else.
Religion: catholic	=1 if a respondent is of catholic religion, 0 else.
Religion: protestant	=1 if a respondent is of protestant religion, 0 else.
Religion: none/other (ref.)	=1 if a respondent belongs to no religion or a non-Christian religion, 0 else.
Body weight (in 2017)	Respondent's body weight in kg in 2017.
Body height	Respondent's body height in cm.
Cognitive skills, economic preferences, and other personality traits	
Fluid intelligence	Respondents are asked to assign as fast as possible numbers from 1 to 9 to signs according to a key that respondents see throughout the test. The test ends after a total of 93 items. The test score is the number of correct assignments in 90 seconds, see Lang et al. (2007), and is standardized to mean 0 and standard deviation 1.
Crystallized intelligence	Respondents are asked to name as many animals as possible in 90 seconds. The test score is the number of uniquely named animals within the time span, see Lang et al. (2007). The test score is standardized to mean 0 and standard deviation 1.
Personality traits	The Big Five personality traits (extraversion, conscientiousness, emotional stability, openness, agreeableness) are measured via 15 items (3 items each, see Gerlitz and Schupp (2005) for the questionnaire) answered on a 7-point Likert scale. Each trait is standardized to mean 0 and standard deviation 1.
Risk tolerance	Answer to "How do you rate yourself personally? In general, are you someone who is ready to take risks or do you try to avoid risks?" on an 11-point Likert scale, standardized to mean 0 and standard deviation 1.
Brief Self-Control Scale	Based on 13 items answered on a 5-point Likert scale, see Table A3 for all items and Tangney et al. (2004) and Cobb-Clark et al. (2019) for more details. The test score is standardized to mean 0 and standard deviation 1.
Outcome Variables (Section 5)	
Choices involving immediate costs and later benefits	
Years of education	Years of education from primary to post-secondary education.

Continued on next page

Table A1 – *continued*

College entrance degree	=1 if a respondent has at least graduated from a *Gymnasium* (academic track) secondary school, 0 else.
Exercise for health reasons	=1 if a respondent reports to engage in physical activities at least once a week and rates the statement "I do sport to stay fit or to improve my fitness and health" higher than "I do sport just for fun, for my personal balance or to be with other people", 0 else.
Any monthly savings	=1 if a household confirms to the question "Do you have normally some money left at the end of a month, which you can save or put aside? [...] We are also looking for precautionary saving such as for a larger purchase or for a state of emergency." with "yes, for precautionary saving", 0 else.
– No mortgage	='Any monthly savings' variable, where respondents in households that complete the statement "Are you living in the dwelling as..." with "owner" (as opposed to "main tenant" or "subtenant") and "Do you still have financial obligations, for example loans or a mortgage, for this house or flat in which you live?" with "yes" are excluded.
Choices involving immediate benefits and later costs	
Alcohol: 4+ days a week	=1 if a respondent reports to drink on at least 4 days of a standard week, 0 else.
Alcohol: 3+ drinks	=1 if a respondent reports to drink at least 3 drinks whenever drinking alcohol, 0 else. Missing if respondent does not drink alcohol.
Smoking	=1 if a respondent reports to smoke, 0 else.
Oversleeping	=1 if a respondent answers the question "I stay two or three times per week longer in bed than I should do" with "always", "often", "occasionally", or "seldom" (as opposed to "never") on a 5-point Likert scale, 0 else.
Take-up of commitment devices	
Savings plan	=1 if a household confirms to the question "Do you have normally some money left at the end of a month, which you can save or put aside? This can include regular savings deposits for asset formation such as: savings plan of bank, a personal pension scheme with state grant (Riester- or Rüruprente), other personal pension schemes, building savings contracts, cash-value life insurances, capital formation savings payment." with "yes, savings for asset accumulation", 0 else.
Exercise in gym/sports club	=1 if a respondent answers the question "Where and with whom do you generally practice this [most or second-most frequent type of sport] sport?" with "at commercial sports provider (e.g., gyms)" or "in a club" and rates the statement "I do sport to stay fit or to improve my fitness and health" higher than "I do sport just for fun, for my personal balance or to be with other people", 0 else (i.e., if respondent does no sport, does sport at different location responding, e.g., "alone and not in an organization" or "together with others, but not in an organization", or engages in sport for fun rather than health purposes).

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Control Variables (Section 5)

Demographic characteristics, 2017 weight, height, patience

Age	*See above.* Enters regressions as control variable through fixed effects.
Female	*See above.*
State of residence	Respondent's federal state of residence. Enters regressions as control variable through fixed effects.
Month of interview	Month respondent is interviewed. Enters regressions as control variable through fixed effects.
First-gen. migration	=1 if a respondent is born outside of Germany, 0 else.
Second-gen. migration	=1 if a respondent is born in Germany but has at least one parent who is born outside of Germany, 0 else.
Number of siblings	*See above.* Set to 0 if missing for inclusion in regression and controlling for missing indicator in addition.
Body weight (in 2017)	*See above.*
Body height	*See above.* Set to 0 if missing for inclusion in regression and controlling for missing indicator in addition.
Patience (in std.)	*See above.* Set to 0 if missing for inclusion in regression and controlling for missing indicator in addition.

Additional Control Variables (for Tables A4 and A7)

Parents (F=father, M=mother)

F: years of education	Years of education (incl. post-secondary education) of a respondent's father.
M: years of education	Years of education (incl. post-secondary education) of a respondent's mother.

Marital status and family

Single (ref.)	=1 if a respondent is single, 0 else.
Married	=1 if a respondent is married, 0 else.
Divorced	=1 if a respondent is divorced 0 else.
Widowed	=1 if a respondent is widowed, 0 else.
One child	=1 if a respondent has one child, 0 else.
Two children	=1 if a respondent has two children, 0 else.
Three or more children	=1 if a respondent has three or more children, 0 else.
Single parent	=1 if a respondent is a single parent, 0 else.
Household income	Household's gross monthly income in 1,000 Euro by the time of the interview. No income is set to 0.
Household size	Number of persons living in the respondent's household by the time of the interview.

Religion

Religion: catholic	=1 if a respondent is of catholic religion, 0 else.
Religion: protestant	=1 if a respondent is of protestant religion, 0 else.
Religion: none/other (ref.)	=1 if a respondent belongs to no religion or a non-Christian religion, 0 else.

Education

Some high school (ref.)	=1 if a respondent's education matches International Standard Classification of Education (ISCED) categories 0, 1, or 2; 0 else.
Academic high school	=1 if a respondent's ISCED category is 3, 0 else.

Continued on next page

Table A1 – *continued*

Post-sec. education	=1 if a respondent's ISCED category is 4 or 5, 0 else.
College education	=1 if a respondent' ISCED category is 6, 0 else.
Labor market	
Working (ref.)	=1 if a respondent is working for pay by the time of the interview, 0 else.
Unemployed	=1 if a respondent is unemployed by the time of the interview, 0 else.
Out of labor force	=1 if a respondent does not belong to the labor force by the time of the interview, 0 else.
Gross labor income	Respondent's gross monthly labor market income in 1,000 Euro by the time of the interview. No labor market income is set to 0.
Unempl. last 10 years	=1 if a respondent reports to have been unemployed at least once in the 10 years before the biography interview, 0 else.
Months in unempl.	Self-reported number of months spent in unemployment in the last 10 years before the biography interview (0 if the respondent was always employed).

Additional Variables (for Table A5)

Exercise for fun	=1 if a respondent reports to engage in physical activities at least once a week and rates the statement "I do sport to stay fit or to improve my fitness and health" lower or equal to the statement "I do sport just for fun, for my personal balance or to be with other people", 0 else. For respondents who do not engage in physical activities at all, the indicators for sport for health reasons and for sport for fun are both 0.
Health	Physical Health Component Summary score (PCS) assessed through 11 items from the SF12 questionnaire asking about an individual's health status (e.g., physical functioning and bodily pain as well as stress and emotional problems). Separate summary scores for physical and mental health are obtained via principal component analysis, see Andersen et al. (2007). The final scores are standardized to mean 0 and standard deviation 1.

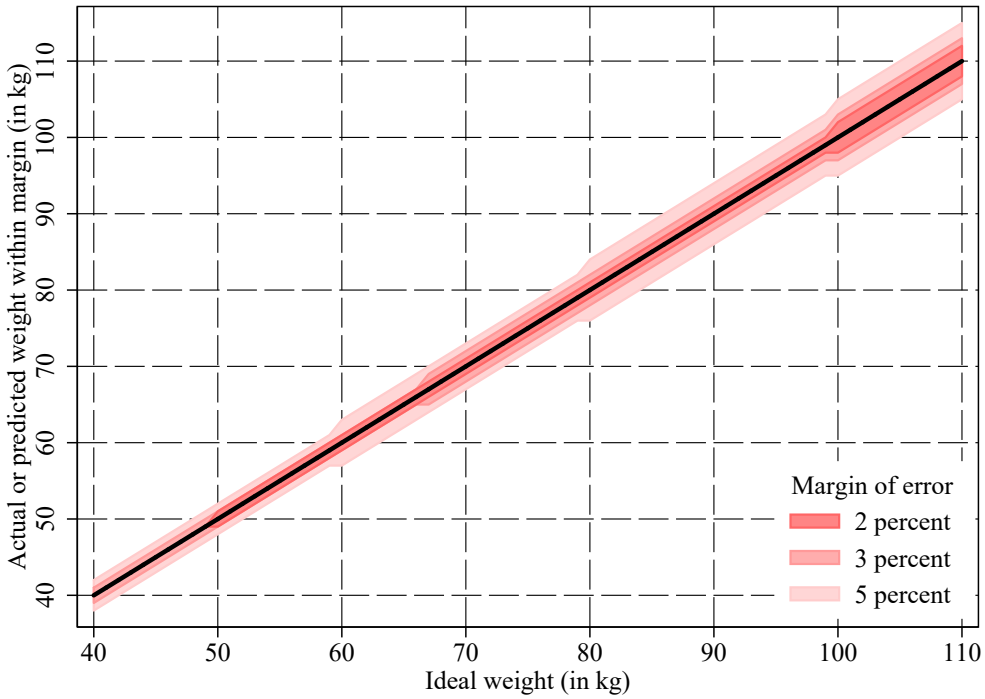
Notes: SOEP-IS based on questionnaires from https://www.diw.de/en/diw_01.c.621450.en/soep_is_2017.html. All information is drawn from 2017 or the most recent retrospective information if part of people's biography, except for exercise (taken from 2019, if available, to avoid reverse causality; otherwise from 2017), patience (2013), cognitive skills (2014), and variables from other Innovation Modules in specific years, see http://companion-is.soep.de/ for an overview: reasons for exercise (assessed on 7-point Likert scales and aggregated over all years available: 2013, 2015, 2017), exercise in gym/sports club (2017), alcohol consumption (2015), smoking (2018), oversleeping (2013).

Table A2: Share of self-control types for alternative sample restrictions

		Type share (in percent)		
Sample restriction	Number of observations (1)	Time-consistents (2)	Naïfs (3)	Sophisti-cates (4)
All restrictions in place (analysis sample)	1,514	33.8	28.7	37.5
Include individuals who want to gain weight[a]	1,644	32.9	29.0	38.1
Include individuals with extreme weight changes	1,559	33.5	28.7	37.7
All individuals (unrestricted sample)	1,692	32.7	29.0	38.4

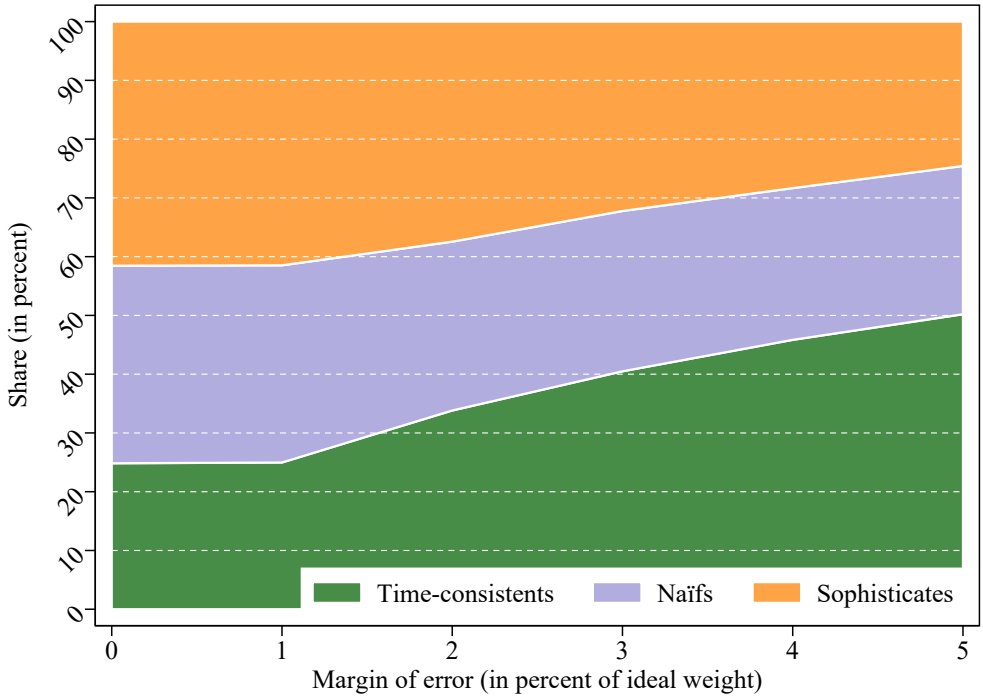
Notes: SOEP-IS, varying samples. Restrictions are relaxed only one at a time (except for last row which relaxes all) and are not necessarily mutually exclusive. [a]Individuals who want to gain weight are classified according to the decision tree but with the inequalities reversed: i.e., if their predicted weight≤ideal weight, they are sophisticated; if not, they are either time-consistent (if their actual weight 2018≥ideal weight) or naïve.

Figure A5: Range of margin of error relative to ideal weight



Notes: Own illustration.

Figure A6: Shares of self-control types along different margins of error



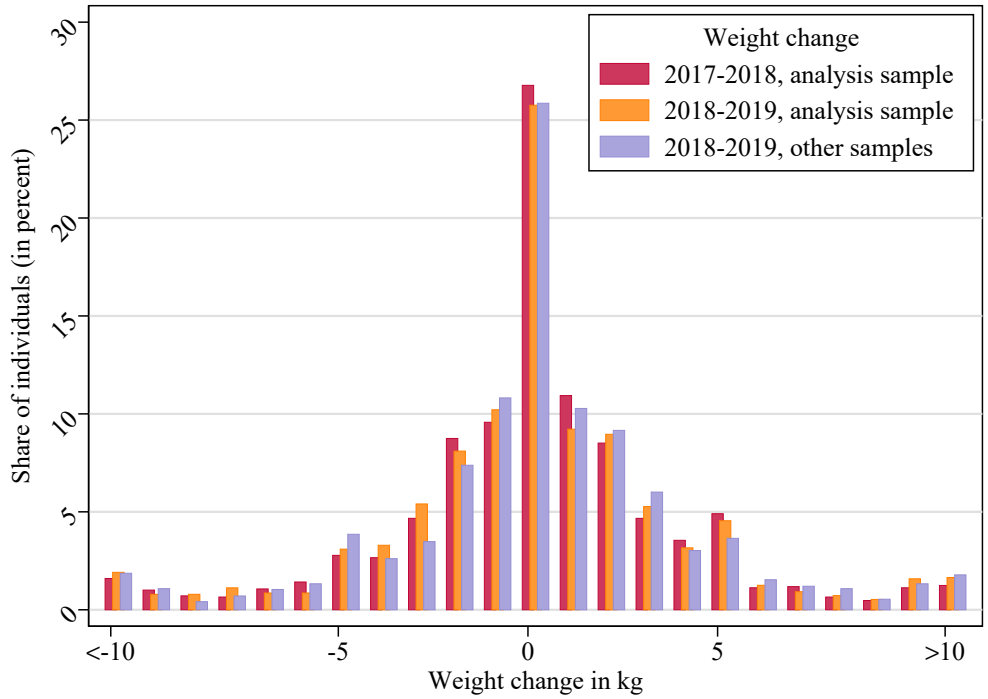
Notes: SOEP-IS analysis sample, 1,514 observations.

Table A3: Brief Self-Control Scale

	Item
1.	I am good at resisting temptation.
2.	I have a hard time breaking bad habits. (reversed item)
3.	I am lazy. (reversed item)
4.	I say inappropriate things. (reversed item)
5.	I do certain things that are bad for me, if they are fun. (reversed item)
6.	I refuse things that are bad for me.
7.	I wish I had more self-discipline. (reversed item)
8.	People would say I have iron self-discipline.
9.	Pleasure and fun sometimes keep me from getting work done. (reversed item)
10.	I have trouble concentrating. (reversed item)
11.	I am able to work effectively towards long-term goals.
12.	Sometimes, I cannot stop myself from doing something, even if I know it is wrong. (reversed item)
13.	I often act without thinking through all the alternatives. (reversed item)

Notes: The Brief-Self-Control Scale is taken from Tangney et al. (2004). Questions marked as "reversed item" enter the final self-control score reversed. The questions are asked in two blocks (block 1: questions 1–6 and 9–13; block 2: questions 7 and 8) separated by other questions.

Figure A7: Weight changes of respondents with and without ideal weight question



Notes: SOEP-IS, several samples. The red bars give the frequencies of weight changes between 2017 and 2018 in our analysis sample, with the ideal weight question asked in 2017 (1,692 observations, no sample restrictions except non-missing weight information). The orange bars give the 2018-2019 weight change for the same sample (1,518 observations due to missing 2019 weight information). The purple bars give the 2018-2019 weight change for SOEP-IS respondents who were not selected to participate in the self-control innovation module and thus did not answer the ideal weight question (2,413 observations). Kolmogorov–Smirnov tests of equality of distributions fail to reject that distributions differ; p-values are 0.99 for red vs. orange observation, 0.88 for red vs. purple observation, and 0.62 for orange vs. purple observations.

Table A4: Additional results for education

Outcome variable	Effect of self-control problem ($\hat{\alpha}_1$) coef. (1)	rel. size (2)	Effect of sophistication ($\hat{\alpha}_2$) coef. (3)	rel. size (4)	Test $\hat{\alpha}_1 = -\hat{\alpha}_2$ (5)	R^2 (6)
Outcome: years of education						
Specification:						
– baseline	-0.422^{**}	-0.033	0.529^{***}	0.042	0.54	0.16
	(0.180)		(0.171)			
– baseline + par. ed. + cry. int.	-0.262	-0.021	0.291^{*}	0.023	0.86	0.31
	(0.164)		(0.156)			
Outcome: college entrance degree						
Specification:						
– baseline	-0.059^{*}	-0.155	0.079^{**}	0.208	0.53	0.10
	(0.033)		(0.031)			
– baseline + par. ed. + cry. int	-0.040	-0.105	0.049	0.128	0.77	0.18
	(0.031)		(0.030)			

Notes: SOEP-IS analysis sample, OLS estimations. Number of observations are 1,491 (years of education in the top panel) and 1,501 (college entrance degree in the bottom panel). The baseline specification in the first row of both panels controls for gender, first- and second-generation migrational background, number of siblings, 2017 weight, height, and patience, as well as a maximum set of fixed effects for state of residence, year of birth, interview month, and a constant. The specification in the second row additionally controls for parental education and respondents' score in a short test of crystallized intelligence (see Table A1, missing test scores are replaced with zero and we control for the replacement). Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A5: Additional estimation results for exercise

	Effect of self-control problem ($\hat{\alpha}_1$)		Effect of sophistication ($\hat{\alpha}_2$)		Test	
	coef.	rel. size	coef.	rel. size	$\hat{\alpha}_2 = -\hat{\alpha}_1$	R^2
Outcome variable	(1)	(2)	(3)	(4)	(5)	(6)
Settings suggesting that exercise involves immediate costs and later benefits						
Exercise for health reasons	−0.055*	−0.245	0.045	0.200	0.72	0.04
	(0.029)		(0.027)			
Exercise if PCS < median	−0.035	−0.083	0.056	0.134	0.66	0.09
	(0.051)		(0.045)			
Exercise if problems climbing stairs	−0.036	−0.095	0.044	0.114	0.89	0.08
	(0.058)		(0.051)			
Exercise if age 50+	−0.076*	−0.152	0.080*	0.159	0.93	0.09
	(0.042)		(0.043)			
Other exercise settings						
Exercise	−0.040	−0.081	0.021	0.042	0.57	0.07
	(0.034)		(0.032)			
Exercise for fun	0.015	0.054	−0.024	−0.087	0.76	0.03
	(0.031)		(0.029)			

Notes: SOEP-IS analysis sample, OLS estimations. Number of observations are 1,514 for estimations without sample restrictions. All estimations control for gender, first- and second-generation migrational background, number of siblings, 2017 weight, height, and patience, as well as a maximum set of fixed effects for state of residence, year of birth, interview month, and a constant. "Exercise for health reasons" is an indicator for exercising at least once a week and additionally assigning health a greater importance as reason for exercising than fun. "Exercise for fun" is an indicator for exercising at least once a week and additionally assigning fun the same or greater importance as reason for exercising than health. For an individual not exercising, the indicators for exercise for health reasons and for exercise for fun are both 0. In all other estimations the outcome variable exercise is an indicator for exercising at least once a week. The following estimations are run conditional on subsamples: respondents with a Physical Health Component Summary Score (PCS, based on the SF-12 health questionnaire, see Table A1) below the median (PCS < median, 753 obs.); respondents reporting to have at least some problems climbing stairs (problems climbing stairs, 606 obs.); respondents aged 50 or older (age 50+, 945 obs.). Standard errors are given in parentheses. Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A6: Additional estimation results for savings

	Effect of self-control problem ($\hat{\alpha}_1$)		Effect of sophistication ($\hat{\alpha}_2$)		Test	
	coef.	rel. size	coef.	rel. size	$\hat{\alpha}_1 = -\hat{\alpha}_2$	R^2
Outcome variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Additionally controlling for household size-adjusted family income						
Any monthly savings	−0.036	−0.061	0.059	0.101	0.53	0.07
	(0.042)		(0.043)			
– No mortgage	−0.056	−0.097	0.088*	0.154	0.44	0.12
	(0.047)		(0.048)			
Savings plan	−0.001	−0.005	0.099***	0.368	0.00	0.17
	(0.034)		(0.036)			
Panel B: Individual-level self-control types						
Any monthly savings	−0.006	−0.011	0.057	0.098	0.14	0.01
	(0.036)		(0.035)			
– No mortgage	−0.025	−0.043	0.106**	0.185	0.05	0.01
	(0.043)		(0.041)			
Savings plan	0.001	0.005	0.118***	0.437	0.00	0.10
	(0.029)		(0.030)			

Notes: SOEP-IS analysis sample, OLS estimations. Number of observations are 1,514 (any monthly savings), 1,136 (any monthly savings, no mortgage), 1,514 (savings plan). All estimations control for gender, first- and second-generation migrational background, number of siblings, 2017 weight, height, and patience, as well as a maximum set of fixed effects for state of residence, year of birth, interview month, and a constant. Panel A additionally controls for household size-adjusted family income. Missing income information is replaced with zero and we include an indicator that controls for this replacement. Panel B considers our preferred set of control variables (without family income) but uses individual-level instead of household-level self-control types. Standard errors are given in parentheses and are clustered at household level. Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A7: Additional estimation results for immediate-benefit choices

	Effect of self-control problem ($\hat{\alpha}_1$)		Effect of sophistication ($\hat{\alpha}_2$)		Test	
	coef.	rel. size	coef.	rel. size	$\hat{\alpha}_1 = -\hat{\alpha}_2$	R^2
Outcome variable	(1)	(2)	(3)	(4)	(5)	(6)
Including additional control variables						
Alcohol: 4+ days a week	0.006	0.034	−0.010	−0.054	0.89	0.10
	(0.027)		(0.026)			
Alcohol: 3+ drinks	0.016	0.052	0.026	0.084	0.21	0.12
	(0.035)		(0.033)			
Smoking	−0.020	−0.090	0.020	0.092	0.99	0.10
	(0.028)		(0.027)			
Oversleeping	0.030	0.088	0.042	0.123	0.17	0.08
	(0.052)		(0.049)			

Notes: SOEP-IS analysis sample, OLS estimations. Number of observations as in Table 8. In addition to the control variables included in the specifications in Table 8 (gender, first- and second-generation migrational background, number of siblings, 2017 weight, height, and patience, as well as a maximum set of fixed effects for state of residence, year of birth, interview month, and a constant), specifications here control for marital status, number of children, household income, religion, indicators of the highest educational degree, current employment status, past employment status, and gross labor market income (see Table A1 for variable definitions). Missing income information is replaced with zero and we include an indicator that controls for this replacement. Standard errors are given in parentheses and are clustered at household level. Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

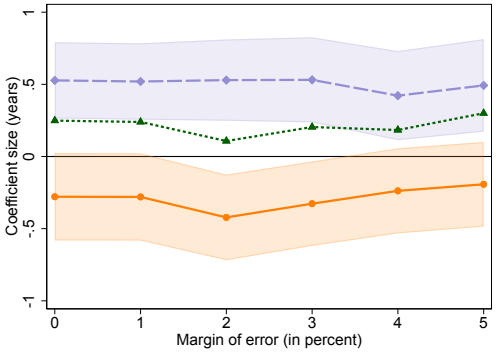
Table A8: Estimation results using unrestricted sample

	Effect of self-control problem ($\hat{\alpha}_1$)		Effect of sophistication ($\hat{\alpha}_2$)		Test	
	coef.	rel. size	coef.	rel. size	$\hat{\alpha}_1 = -\hat{\alpha}_2$	R^2
Outcome variable	(1)	(2)	(3)	(4)	(5)	(6)
Choices involving immediate costs at later benefits						
Years of education	−0.447***	−0.036	0.471***	0.038	0.88	0.14
	(0.171)		(0.162)			
College entrance degree	−0.059*	−0.160	0.061**	0.165	0.96	0.10
	(0.030)		(0.029)			
Exercise for health reasons	−0.061**	−0.281	0.023	0.107	0.14	0.04
	(0.027)		(0.025)			
Any monthly savings	−0.002	−0.004	0.035	0.060	0.30	0.01
	(0.032)		(0.031)			
– No mortgage	−0.010	−0.018	0.081**	0.145	0.05	0.01
	(0.038)		(0.036)			
Choices involving immediate benefits at later costs						
Alcohol: 4+ days a week	−0.009	−0.049	0.003	0.014	0.79	0.10
	(0.025)		(0.024)			
Alcohol: 3+ drinks	0.021	0.068	0.032	0.104	0.09	0.12
	(0.032)		(0.031)			
Smoking	0.000	0.001	0.013	0.055	0.61	0.07
	(0.027)		(0.026)			
Oversleeping	0.030	0.090	0.020	0.061	0.29	0.08
	(0.048)		(0.045)			
Take-up of commitment devices						
Savings plan	−0.018	−0.068	0.101***	0.387	0.00	0.09
	(0.028)		(0.026)			
Exercise in gym/sports club	−0.025	−0.255	0.033*	0.338	0.67	0.02
	(0.019)		(0.018)			

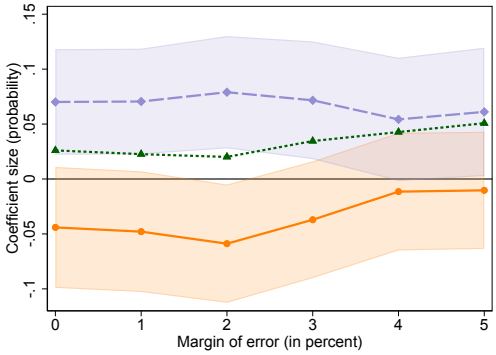
Notes: SOEP-IS unrestricted sample, OLS estimations. Number of observations vary by outcome, see Table 6. All estimations control for gender, first- and second-generation migrational background, number of siblings, 2017 weight, height, and patience, as well as a maximum set of fixed effects for state of residence, year of birth, interview month, and a constant. Individuals who want to gain weight are classified according to the decision tree but with the inequalities reversed: i.e., if their predicted weight≤ideal weight, they are sophisticated; if not, they are either time-consistent (if their actual weight 2018≥ideal weight) or naïve. Standard errors are given in parentheses and are clustered at household level for monthly savings, savings plan, and home owner. Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Figure A8: Estimation coefficients along margin of error for selected outcome variables

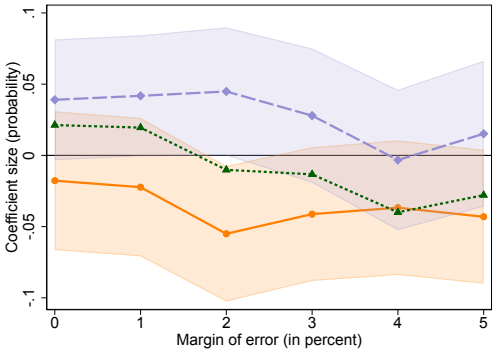
(a) Years of education



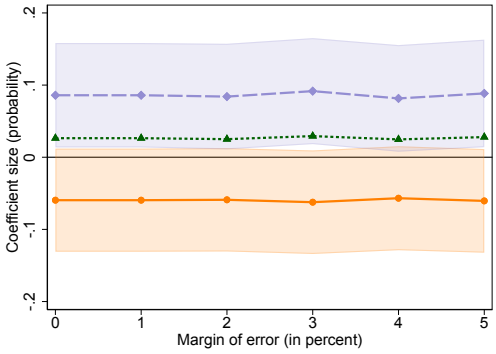
(b) College entrance degree



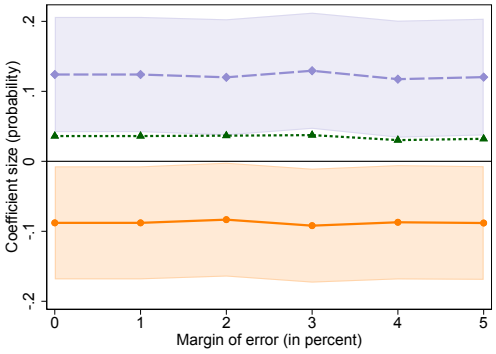
(c) Exercise for health reasons



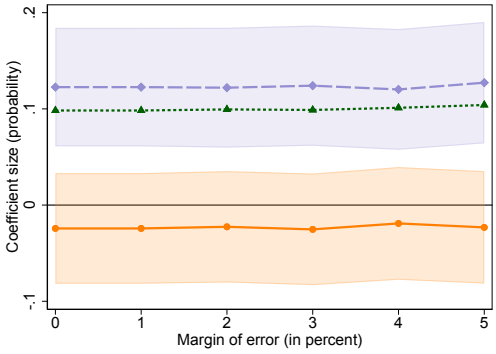
(d) Any monthly savings



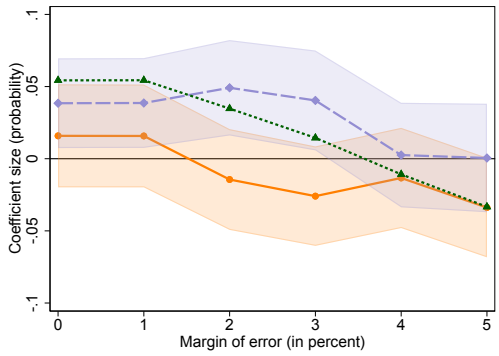
(e) Any monthly savings, no mortgage

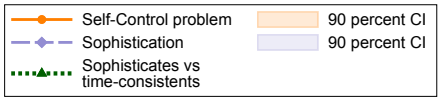


(f) Savings plan



(g) Exercise in gym/sports club





Notes: SOEP-IS analysis sample, own illustrations based on OLS estimations. Number of observations and specifications as in Tables 7 to 9. Coefficients of self-control problem indicator and of sophistication indicator are displayed in orange and purple, respectively. The total effect of sophistication relative to time-consistency (i.e., the sum of the present-bias and sophistication effect) is plotted in green. For all savings variables, self-control and sophistication indicators are based on type of both spouses for couple-headed households and standard errors are clustered at household level.

Table A9: Probit estimation results

	Effect of self-control problem		Effect of sophistication	
Outcome variable	coeff-icient (1)	marg. effect (2)	coeff-icient (3)	marg. effect (4)
Choices involving immediate costs at later benefits				
College entrance degree	−0.178*	−0.059	0.260***	0.086
	(0.097)		(0.094)	
Exercise for health reasons	−0.194*	−0.056	0.184*	0.053
	(0.107)		(0.105)	
Any monthly savings	−0.165	−0.060	0.234**	0.086
	(0.112)		(0.115)	
– No mortgage	−0.235*	−0.084	0.337***	0.121
	(0.127)		(0.130)	
Choices involving immediate benefits at later costs				
Alcohol: 4+ days a week	−0.011	−0.003	0.051	0.012
	(0.119)		(0.119)	
Alcohol: 3+ drinks	0.057	0.017	0.080	0.024
	(0.115)		(0.108)	
Smoking	−0.048	−0.013	0.007	0.002
	(0.108)		(0.100)	
Oversleeping	0.114	0.034	0.136	0.041
	(0.161)		(0.149)	
Take-up of commitment devices				
Savings plan	−0.064	−0.018	0.409***	0.116
	(0.127)		(0.128)	
Exercise in gym/sports club	−0.114	−0.020	0.372***	0.067
	(0.139)		(0.135)	

Notes: SOEP-IS analysis sample, Probit estimations. Number of observations vary by outcome, see Table 6. All estimations control for gender, first- and second-generation migrational background, number of siblings, 2017 weight, height, and patience, as well as a maximum set of fixed effects for state of residence, year of birth, interview month, and a constant. Coefficients of self-control problem indicator (column 1) and sophistication indicator (column 3); corresponding marginal effects (columns 2 and 4). For any monthly savings and savings plan, self-control and sophistication indicators are based on type of both spouses for couple-headed households. Standard errors are given in parentheses and are clustered at household level for monthly savings, savings plan, and home owner. Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Online Appendix B Representativeness of Sample

The SOEP-IS was designed to be a representative sample of households and individuals from a cross-sectional and longitudinal perspective (Richter and Schupp, 2015).[34] Therefore, the SOEP-IS stands alone as a representative sample of the German population separate from the main survey of the SOEP, sometimes refereed to as SOEP-Core to distinguish it from the Innovation Sample. Our final sample, however, is smaller than the initial and full SOEP-IS for several reasons, which may introduce selection: (i) the additional body weight questions were only measured for two sub-samples of the SOEP-IS; (ii) we have to drop observations with incomplete responses in key variables; and (iii) there is some sample attrition over time.

To test for the representativeness of our sample with respect to the German population, we conduct a careful analysis that investigates whether our final sample and the much larger SOEP-Core are balanced in terms of the most critical demographic characteristics. For this exercise, we consider the largest possible sample of SOEP-Core respondents among all initial and refreshment sub-samples that were first surveyed before the initiation of the Innovation Sample in 2012.[35] From this potential SOEP-Core sample, we consider all respondents with complete basic demographic information, totaling to 20,545 observations in 2016, and compute weighted averages based on the individual cross-sectional weights provided by the SOEP (for details, see Kroh et al., 2015) that are essential for representativeness of the German population.

Table B1 presents the sample averages, together with corresponding standard deviations, of our SOEP-IS sample[36] and the SOEP-Core sample (see columns 1 to 4). Column 5 contains the p-value of two-sided t-test for statistical differences between the two averages. Most of the variables thus are very well balanced, although some p-values suggest a statistically significant difference. The mean years of education differ at the 5 percent level, however, the economic difference seems less substantial; 12.55 years in our SOEP-IS extract versus 12.39 in the SOEP-Core. Labor force participation is somewhat lower in our SOEP-IS extract at 58 compared to 65 percent in the SOEP-Core. In line with the lower labor force participation, the respondents in our sample have, on average, more children (1.45 versus 1.29). They are also more likely to be married (57 versus 50 percent). Most importantly, the mean comparison indicates no difference in respondents' body weight and height. The average weight in our sample is 78.4 kg, respondents in the SOEP-Core data weigh, on average, 150 grams more. Note, we conduct the balancing exercise allowing for respondents in the SOEP-Core data to have missing weight information. Hence, the equal means in the considered characteristics indicate that our SOEP-IS extract is representative in spite of some respondents in the SOEP-IS not reporting their weight.

As the mean of the body weight across the samples might conceal differences in the weight distributions, Figure B1 compares them.[37] Both weight distributions seem very similar at first glance. A Kolmogorov–Smirnov test for equality of the distributions confirms that they are not statistically different from each other (p-value 0.47).

[34] This subsection borrows from Cobb-Clark et al. (2019).

[35] This way, only the most recent sub-samples entering the SOEP-Core in 2013 or later are excluded, which have an exclusive focus on migrants.

[36] We use the sample with complete information in key variables, before excluding individuals who want to gain weight and with more than 10kg weight changes.

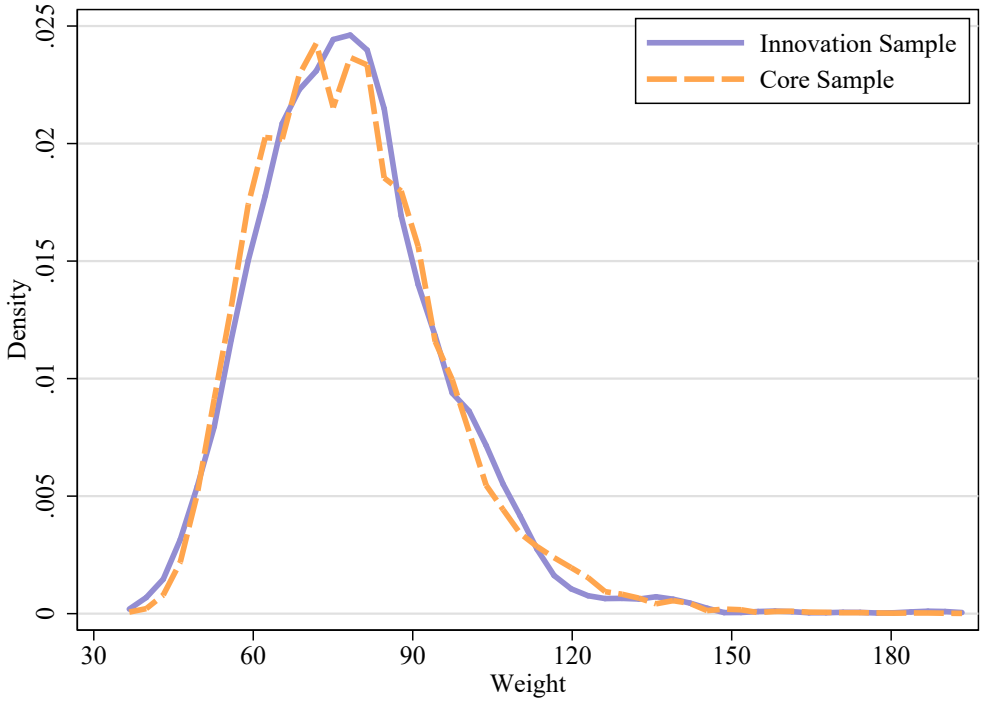
[37] Most other variables considered here are binary and the t-test of equal means assesses the distributions.

Table B1: Balancing table comparing our final SOEP-IS sample with SOEP-Core sample

	(1) Innovation Sample	(2)	(3) Core Sample	(4)	(5) p-value
	Mean	std.	Mean	std.	eq. means
Demographics					
Female	0.517	(0.500)	0.516	(0.500)	0.957
Age	53.739	(18.073)	53.206	(18.580)	0.256
No migrational background	0.817	(0.387)	0.829	(0.376)	0.193
East (current)	0.220	(0.415)	0.216	(0.411)	0.648
East (in 1989)	0.202	(0.401)	0.192	(0.394)	0.338
Religion: catholic	0.262	(0.440)	0.276	(0.447)	0.216
Religion: protestant	0.322	(0.467)	0.308	(0.462)	0.253
Weight and height					
Weight (2017, in kg)†	78.410	(17.422)	78.555	(17.785)	0.746
Height (2017, in cm)†	171.467	(9.440)	171.845	(9.689)	0.122
Education					
Years of education†	12.546	(2.763)	12.391	(2.731)	0.027
Mother: intermediate schooling and above	0.317	(0.465)	0.307	(0.461)	0.380
Father: intermediate schooling and above	0.297	(0.457)	0.295	(0.456)	0.873
Labor market					
Labor force participation	0.576	(0.494)	0.652	(0.476)	0.000
Unemployed	0.032	(0.176)	0.037	(0.189)	0.261
Gross monthly income (in Euros)†	2813.560	(2119.253)	2745.609	(2422.733)	0.428
Household and Family					
Married	0.566	(0.496)	0.500	(0.500)	0.000
Divorced	0.130	(0.336)	0.126	(0.332)	0.714
Number of children	1.447	(1.229)	1.292	(1.234)	0.000
Single parent	0.057	(0.233)	0.058	(0.233)	0.944
Observations	**1,692**		**20,545**		

Notes: Own calculations based on SOEP-IS, wave 2017, and SOEP-Core, wave 33 (1984–2016). Column 1 gives the unconditional mean of the variable stated on the left for Innovation Sample observations with complete self-control information. Column 2 gives the standard deviation of the variable. Columns 3 and 4 include the population-weighted mean and standard deviation for the corresponding variables in the Core Sample of the SOEP. Column 5 states the p-value of a conventional t-test of equal means between the two sample. Variables marked with † have fewer observations than all others. Age is measured as 2017 minus the year of birth, such that it captures age in 2017 in both datasets.

Figure B1: Weight distribution in SOEP-IS and SOEP-Core samples



Notes: SOEP-IS sample, 1,692 observations. SOEP-Core sample, 20,227 observations. Kolmogorov-Smirnov test of equality of distribution (H_0) cannot be rejected (p-value 0.47).

Table B2: Missing body weight information

Panel A	Share of item non-response (in percent)
Weight 2017	1.80
Ideal weight	2.42
Predicted weight	3.03
Weight 2018	1.97
Any of the four	4.94

Panel B	Mean of variable, if any weight measure is		
	missing	not missing	p-value of difference
Female	0.67	0.52	0.00
Age (in years)	57.53	53.74	0.05
Lived in 1989: east	0.15	0.20	0.22
First-gen. migration	0.06	0.09	0.27
Married	0.52	0.57	0.43
College education	0.16	0.23	0.13
Household income	3.06	3.14	0.67
Gross labor income	2.88	2.81	0.87
Religion: catholic	0.30	0.26	0.49
Religion: protestant	0.33	0.32	0.88
Fluid int. score (in std.)	−0.05	0.00	0.68
Brief Self-Control Scale (in std.)	−0.18	0.01	0.13

Panel C	Average weight 2017, if variable is		
	missing	not missing	p-value of difference
Ideal weight	86.16	78.50	0.06
Predicted weight	80.56	78.56	0.56
Weight 2018	87.86	78.47	0.01

Notes: SOEP-IS full sample, 1,780 observations.

Online Appendix C Compulsory Schooling Reform Estimations

After four years of elementary schooling, students in Germany are tracked into one of traditionally three forms of secondary schools: basic schools (*Hauptschulen*), intermediate schools (*Realschulen*), or academic schools (*Gymnasien*).[38] Historically, the majority of students visited basic schools (see below), where they graduated after having received eight years of schooling in total (four years of elementary schooling and four years of basic schooling). As intermediate and academic schools provide a total of ten and 13 years of schooling, respectively, basic schools set the mandatory minimum years of schooling in Germany. Against this background, the German states (that were and are in charge of educational policy) introduced reforms that increased the compulsory years of schooling by introducing a mandatory ninth grade for basic school students.

The discussion to introduce a ninth grade dates back to the immediate aftermath of World War II. Weak labor market conditions were the main reason for extending the time spent in school at first, e.g., when the states of Berlin and Hamburg implemented their compulsory schooling reform in 1949. By the time more states introduced mandatory ninth grade on a state-wide level (e.g., Schleswig-Holstein in 1956 and Bremen in 1958), the economic situation was no longer the main reason (see Pischke and von Wachter, 2008). A lack of maturity in 14-year-olds and an increased demand for skilled workers had become more pressing issues. In 1964, the prime ministers of all states agreed upon introducing a ninth grade in the Hamburg Accord and all states had introduced it by 1967 (with the exception of Bavaria that followed in 1969). Table C1 gives the year of introduction, the first birth cohort affected, and the share of students in basic schools by state.

Table C1: Introduction of the compulsory ninth grade for basic schools

State	(1) First graduation year affected	(2) First birth cohort affected	(3) Share of basic school students (in percent)
Baden-Württemberg	1967	1953	77.3
Bavaria	1969	1955	81.1
Berlin	*1949*	*1934*	*69.0*
Bremen	*1958*	*1943*	*73.4*
Hamburg	*1949*	*1934*	*74.2*
Hesse	1967	1953	72.4
Lower Saxony	1962	1947	78.0
North Rhine-Westphalia	1967	1953	76.9
Rhineland-Palatinate	1967	1953	82.4
Saarland	1964	1949	83.1
Schleswig-Holstein	1956	1941	71.4
Average			77.4

Notes: Own representation. Information in columns 1 and 2 is taken from the working paper version of Pischke and von Wachter (2008) (Pischke and von Wachter, 2005, Table 1). Column 3 is calculated based on information from the German Federal Statistical Office (1967, p. 92). The first column gives the year the ninth grade was introduced. Column 2 gives the approximate birth cohort (=year of introduction−15 as there are nine years of schooling with a school starting age of 6). Column 3 states the share of students in basic schools in 1964. We assign individuals as affected by the compulsory school law change if they currently live in the state given on the left of this table and were born in the year stated in column 2 or later. Because our data only include the current state of residence, but no retrospective information on the state of birth or school graduation, we measure compulsory schooling exposure with measurement error. To safeguard against mis-assignment we exclude information on respondents that report to have lived outside West Germany in 1989. Respondents living in the "city states" of Berlin, Hamburg, and Bremen (printed in italics) are excluded as well.

[38] This subsection borrows from the one in Cobb-Clark et al. (2019).

To estimate the effect of the compulsory reforms on years of schooling (without post-secondary education), we regress years of schooling on a reform indicator (one if treated, zero otherwise), gender, and full sets of state and birth-cohort fixed effects as well as state-specific linear trends. We additionally control for 2017 weight and height as potentially important determinants of the self-control type. This regression constitutes the first stage of the 2SLS approach. The point estimate and the F-statistic of the instrument are shown in first and second column of Table C2. In our preferred specification, shown in the top panel of the table, we restrict the estimation sample to birth cohorts 1945–1975 to minimize the potentially confounding impact of other societal changes over time. Because our data do not include the federal state of birth or school graduation, we assign the reform status based on the year of birth and the current state of residence. However, as pointed out by Pischke and von Wachter (2008) (and their reference to Pischke, 2007), using the current state of residence is a good approximation as cross-state mobility is low in Germany, especially for people with low educational attainment. To further safeguard against false assignment, we exclude individuals reporting to have lived outside of West Germany in 1989 and individuals living in the urban "city states" of Berlin, Hamburg, and Bremen. Furthermore, we follow Pischke and von Wachter (2008) and limit the sample to individuals most likely to be affected by the reform. Apart from basic school students that were directly affected, this also includes intermediate school students. While the introduction of the compulsory ninth grade for basic schools did not change the basic school graduation certificate, it reduced the opportunity costs of attending an intermediate school to obtain a higher degree at ten years of education in total (see Cygan-Rehm, 2021). In the second stage, we regress (i) the likelihood of having a self-control problem (column 3) and (ii) conditional on having a self-control problem, the chances of being sophisticated (column 4), on instrumented years of schooling and the same control variables as in the first stage.

The remaining panels of Table C2 present several robustness checks regarding the baseline specification. In the second panel, we allow for a wider time window around the affected cohorts to be able to consider more observations. In panels three and four, we include individuals from Hamburg and Bremen (Berlin remains excluded as we cannot distinguish between East and West Berlin). In the bottom panel, we do not control for state-specific linear trends. When widening the time window, the F-statistic of the reform indicator on the first stage increases. However, the point estimates in the second stage remain rather fuzzy and do not indicate that there is a systematic relationship between the instrumented years of schooling and the self-control problem and sophistication indicators.

Regarding the related literature that analyzes changes to the compulsory schooling laws in Germany, Pischke and von Wachter (2008) find zero wage returns—although this result has recently been challenged by Cygan-Rehm (2021). Considering non-pecuniary outcomes, reform-induced schooling had a positive effect on long-term health for men with mixed evidence for BMI and smoking (Kemptner et al., 2011) and on attitudes towards migration (Margaryan et al., 2021), negative effects on completed fertility (Cygan-Rehm and Maeder, 2013), and no effect on crystallized intelligence (Kamhöfer and Schmitz, 2016) or political participation (Siedler, 2010). Kassenboehmer et al. (2021) analyze how changes to compulsory schooling in two Australian states affect the Big Five traits and locus of control. They find that additional schooling increases agreeableness and internal locus of control in men, but decreases internal locus of control in women. Most closely related to this IV investigation, we estimate the IV effect of compulsory schooling on BSCS trait self-control in Cobb-Clark et al. (2019). There as well, we find no indication that self-control varies systematically in instrumented years of schooling.

Table C2: IV estimates for the effect of years of schooling on self-control and sophistication

	First stage		Second stage		
	Effect of reform on		Effect of years of schooling on		
	Years of schooling	F-stat.	Self-Control problem	Sophistication	Obs.
	(1)	(2)	(3)	(4)	(5)
Baseline specification (cohorts 1940–1975, excluding Hamburg and Bremen)					
Coefficient	0.741***	8.314	0.056	−0.111	500
	(0.257)		(0.151)	(0.192)	
Cohorts 1930–1990, excluding Hamburg and Bremen					
Coefficient	0.934***	13.288	0.108	−0.026	670
	(0.256)		(0.113)	(0.173)	
Cohorts 1940–1975, including Hamburg and Bremen					
Coefficient	0.602**	6.194	0.119	−0.148	516
	(0.242)		(0.185)	(0.205)	
Cohorts 1930–1990, including Hamburg and Bremen					
Coefficient	0.814***	12.168	0.146	−0.052	691
	(0.233)		(0.130)	(0.180)	
Cohorts 1930–1990, excluding Hamburg and Bremen, no state-specific linear trends					
Coefficient	0.686***	11.219	0.143	−0.089	691
	(0.205)		(0.141)	(0.203)	

Notes: SOEP-IS, subsample of analysis sample. The effect of state-year-level compulsory schooling law indicators on years of schooling is stated in column 1 along with first-stage F-statistic in column 2. Compulsory schooling law changes are taken from Pischke and von Wachter (2005, 2008) and indicators are assigned based on the current state of residence (as best available proxy for state of schooling) and the year of birth. The effect of fitted years of schooling on an indicator for having a self-control problem is reported in column 3 and of sophistication in column 4 (excluding time-consistents). Column 3 and 4 are based on two separate 2SLS estimations. First-stage results and number of observations (in column 5) are taken from the first 2SLS estimation (on self-control problem). The second 2SLS estimation (on sophistication) is performed on a subsample that excludes time-consistents. Sample restrictions: We drop respondents who lived outside of West Germany in 1989 (since the reforms only affected West German states). As the reform only affected students in the basic track schools and some may have moved on to the next higher track, intermediate schools, we focus on individuals with degrees from those tracks or with degrees from vocational schools that require a similar number of years of education. In the baseline specification, we exclude individuals from the small states Hamburg and Bremen (more prone to mis-assignment of the instrument with higher likelihood of out-of-state moving) and focus on birth cohorts around the compulsory schooling law changes (1940–1975); both of which are varied in the additional panels. Control variables include gender, body weight and height in 2017, year-of-birth and state fixed effects, and (except for bottom panel) state-specific linear time trends. Standard errors are given in parentheses and are clustered at state-birth-cohort. Significance levels: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

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